POWER PLANT ENGINEERING

CONTENTS FOR THE MONTH OF

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The model contains ¾ mile of boiler and furnace tubes and 2800 ft. of superheater tubes all of which were rolled into the drums and headers. Over 11,000 slip spacers about 1/10 in. thick were welded to the superheater elements and the supporting framework, which is a replica of the steelwork in the Rouge plant required the punching of 35,000 rivet holes and the placing of 14,000 tiny rivets.

Born Out Of A Tea Kettle

DURING our browsing around boiler rooms in power plants throughout the country, we have often wondered what a modern large boiler—steam generators they call them nowadays—really looked like. Trying to form a conception of a modern boiler either during construction or afterwards is much like not being able to see a forest for the trees; there is simply too much boiler for the eye to take in. Of course there are blueprints to look at but even with their aid it is difficult to visualize a steam generator in three dimensions. For these reasons we find the photograph on this page very interesting; it shows us for the first time what a modern large boiler really looks like. Take a good look at it; do you wonder why boiler designers go nuts? What do you suppose James Watt would think of it if he could come back to see it? Is it possible that this strange contraption was born out of a tea kettle?

This beautifully constructed model is a feature of the Combustion Engineering Co. exhibit at the New York World's Fair this year. It represents the latest of two, one million lb. per hr., 1400 lb., 925 deg. F. units at the Rouge plant of the Ford Motor Co. It was built by E. C. Keithley, service engineer of Combustion Engineering Co. It is made entirely of aluminum, stands 6 ft. high and reproduces every detail of the actual unit on a ¾ in. to the foot scale.

WITH THE EDITORS

Betterment of Load Curve

WITH a drop of around 37 per cent in the electric load on all of the country's utility plants between January and May of this year, even though the load is 10 per cent higher than last year this time and seasonal all-time high for the country, a definite upward turn may be expected in the curve about the first of June if the trend follows that of the past several years. Without question seasonal business conditions control the electric load curve but it is interesting to note how certain trends in the use of electricity are affecting the seasonal load.

Seasonal loads, however, vary with the prevailing temperature and the habits of the people of the local communities. Some industrial plants that depend upon exhaust steam for space heating only close down completely during the non-heating season and purchase their electric power needs from the utilities, commercial ice-making and refrigeration plants have increased loads and of more recent years the cooling of nearly all types of buildings for the comfort of the occupants has placed a sizable load on the electric utilities during the summer months.

Changes in the residential load over the country to even out the swings are not so easy to accomplish as those in industrial load. Living habits have to be changed, desires must be created among the masses of people, vast marketing programs for the sale of appliances must be carried on and through it all the customers must be pleased both with the services rendered by the electricity and the price paid.

Lighting of course ranks first among the residential uses of electricity with a total consumption in 1939 of 7460 million kw-hr. which is a little more than one third of the total domestic load of 21,150 million kw-hr. Among the appliances, refrigerators rank first in volume of consumption with 4632 million kw-hr. in 1939; ranges second with 2147 million; radios and phonographs third with 6880 million; water heaters fourth with 1630 million kw-hr.; and on down the line in the order of their power consumption we find electricity used for flatirons, oil burners, washing machines, vacuum cleaners, roasters, toasters, percolators, clocks, ironing machines and space heaters, which used the least amount in the list with an annual consumption of 100 million kw-hr.

The use of these appliances has been remarkably effective not only in evening out the seasonal swing in the residential load but for some reason the low period of residential consumption has been shifted during the past 10 yr. from August to May, the peak occurring in December during the past 5 yr. and in January from 1930 to '34. The dip in the load curve from high to low load ranged from 41.5 per cent in 1928 to 19.75 per cent in 1939. Thus we have witnessed over the past decade radical changes in domestic habits as a result of making important electrical appliances available to a large percentage of the customers. These changes have been beneficial to the health and comfort of the people as well as an economic advantage to the utilities. And although the average current consumption per customer has increased approximately 80 per cent, from 502 to 900 kw-hr., the average annual bill has increased only 11.5 per cent, $31.78 to $36.54.

Averages and totals may mean little to the individual customer or to an individual utility system, but a wide divergence in the wrong direction from the averages calls for an investigation and an explanation, perhaps betterments can be made. Certainly the improvement made in the summer domestic load curve is an indication of what can be done when the industry as a whole works toward a definite objective.

Needed—Infant Idea Farms

RESEARCH laboratories throughout the country are filled with fundamental data that have never been used to benefit the human race only because the cost of developing the ideas into commercial products by the usual methods is considered too great by the owners of the ideas to warrant the expenditure and the risk of failure. The same may be said about undeveloped patents, although in these cases the ideas are public documents which can be studied by any interested individuals, and many a buried patent has been rescued from oblivion by commercially minded men who had the ability to put a product on the market in such a way as to make it a profitable investment, not only for the manufacturer but the consumer as well.

Time and again POWER PLANT ENGINEERING editors have been told in confidence of manufactured products that are ready and waiting to be placed in service but have not as yet been in actual commercial use. The risk of failure seems to dominate the thinking of too many plant managers who are not able to judge the practicability of equipment that is in the process of development. Manufacturers need the assistance of the field in getting money saving equipment on the market and perfecting defects. Consumers of manufactured products need improved equipment to cut down costs. The quicker they can get together in cooperative projects the sooner will their profits be realized. Industry needs a catalist, a carrier, a messenger boy, some agency that can make latent ideas grow into products that are wanted and accepted by the public. Every power plant in the country can be an experimental laboratory, if only a small one, and be a benefit to the entire field. Why not give infant ideas a chance to grow?

MILLERS FORD — Three Years of HIGH TEMPERATURE OPERATION

Part I—Detailed operating record of the first hydrogen cooled generator and high head boilers of this pressure and type in commercial operation, a 30,000 kw., 1200 lb., 900 deg. F. top which cut the station heat rate from 19,940 to 14,990 B.t.u. per net kw-hr. ..A second top section, incorporating 3 yr. of operating experience, is almost ready for service and will relegate all low pressure boilers in the plant to standby service.

By R. D. GILLESPIE
Chief Engineer of Power Plants
The Dayton Power & Light Co.
Dayton, Ohio

DURING THE SUMMER of 1937 the new top on Millers Ford Station, consisting of a 1200 lb., 900 deg. F., 30,000 kw., 3600 r.p.m. hydrogen cooled generator and two 375,000 lb. per hr. pulverized coal fired high type boilers with damper control of steam temperature was put into service. Inasmuch as this involved the first regular commercial operation of the hydrogen cooled generator and high type boilers of this pressure and type, more than the usual starting up difficulties were anticipated. During the ensuing 30 months, however, the availability of the boilers has been 86 per cent and the turbine 94 per cent as shown in more detail by Table I. The longest continuous boiler run, 171 da. during which some 1,100,000 M. lb. of steam was generated, was termined for routine inspection and could safely have been continued much longer.

Such difficulties as have been encountered have been of an extremely minor nature and will be covered in detail later. In the meantime the best measure of the station as a whole, and the individual pieces of equipment, is the fact that the second top, which will soon go into service, is an exact duplicate of the first, incorporating only a few detail changes found desirable by 3 yr. of operation.

While there has been some criticism of the top or superposed plant as a panacea for all power plant ills, it worked in ideally at Millers Ford due primarily to the limited quantity of condenser cooling water. Located on the Miami River, just south of Dayton, O., the original station[1] with two 12,500 kw., 230 lb. ga., 550 deg. F. units was completed in 1918. Subsequently three 20,000 and one 25,000 kw. units

[1]The Millers Ford Station. Power Plant Engineering, p. 825, Oct. 15, 1918.

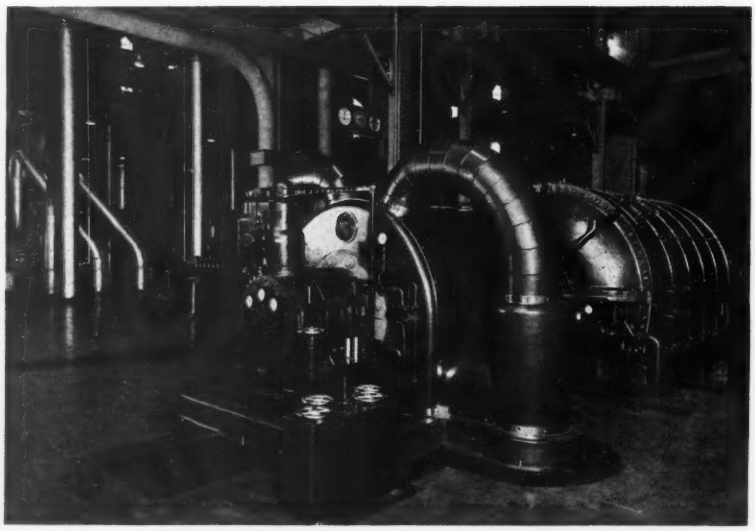

Fig. 1. General view of the station looking from the 30,000 kw., 1250 lb., 900 deg. F. top Unit No. 7 toward the two 375,000 lb. per hr. boilers. Each boiler is fired by three pulverizers through six burners. The new Unit No. 8 will be at the far end of No. 7 generator as shown by the plan, Fig. 2. Figure 7, a view between the boilers, was taken from a point at the right of the boiler feed pump which can be seen just beyond the end of the turbine

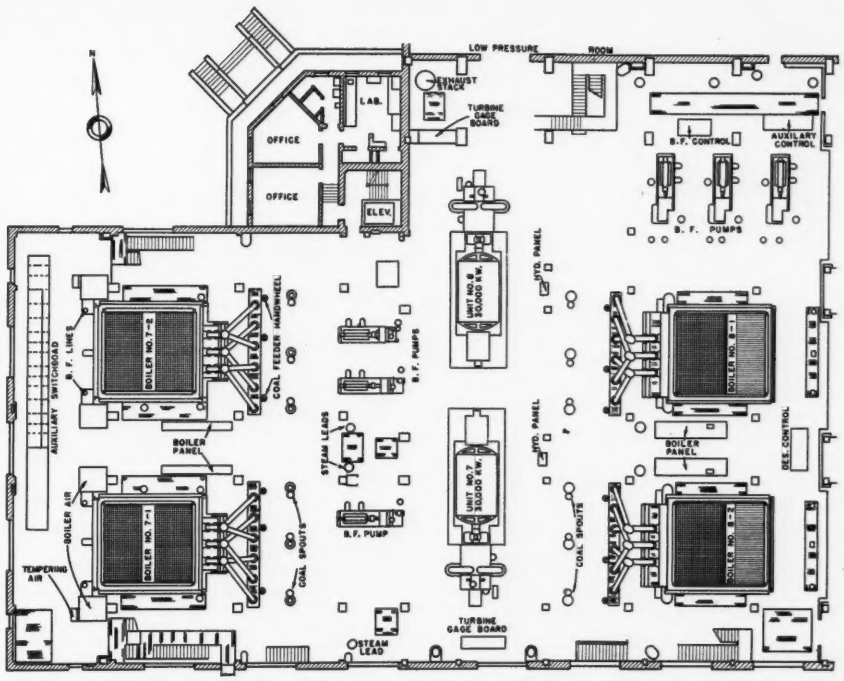

Fig. 2. Plan of the firing floor with the two original high pressure boilers at the left and the two new boilers at the right. Turbines, boiler control panels and boiler feed pumps are all on the same floor with no curtain walls. Pulverizers and coal scales are on the floor below, fans on the floor above, as shown by Fig. 3. This convenient arrangement makes it possible to operate the first top section with a crew of five men per shift which will be increased to nine when Unit No. 8 goes into service

were added, bringing the station capacity up to 110,000 kw. by 1928. All boilers were of the straight tube type fired by underfeed stokers and set in four rows of three each, with the firing aisles at right angles to the turbine room.

During the summer of 1935 a removable dam 9 ft. high was installed across the river below the condenser intake to insure adequate cooling water for condenser operation, and by means of recirculation and natural cooling, augment the natural condensing capacity of the stream flow.

Load increases indicating the need for additional capacity by about 1937 led to engineering studies and the conclusion that this need could best be met by a top plant of from 25,000 to 30,000 kw. and that a decrease in the station coal rate from about 1.5 to 1.00 lb. per kw. might be expected. Actually the station heat rate was reduced from about 19,940 to 14,990 B.t.u. per net kw-hr. as shown by Fig. 5.

Space for the new plant, 104 by 95 ft. and 98 ft. high, was provided by removing three of the oldest boilers to make room for the new turbine and extending the new building beyond the south west corner of the old building line, for the two new boilers. For the second top, Unit No. 8, one additional row of old boilers was removed, giving a completed plant as shown by Fig. 2. This plan, together with the cross sections, Fig. 4, shows the convenient arrangement with no curtain walls.

The two top turbines are set between the two rows of boilers with the boiler feed pumps on the main operating floor, the pulverizers in the basement and the fans on the level above. This open arrangement with the equipment all concentrated on three floors simplifies the operating problem. In addition to a shift engineer for entire station the operating crew for Unit No. 7 consists of five men: two firemen; one pulverizer man; one fan man; and one turbine man. When Unit No. 8 is completed this force will be increased by two firemen; one turbine man; and one pulverizer man.

Unit No. 8 will bring the total station capacity up to 170,000 kw., about a 65 per cent increase without affecting the cooling water requirements. Inasmuch as each top turbine at 30,000 kw. load will supply sufficient steam for about 45,000 kw. of low pressure capacity, the low pressure boilers will in the future be needed only in emergency or extreme peak load conditions.

Table I. Summary of availability and service hours from initial operation through April, 1940. The difference between the time available and time operated indicates outages caused by related units, auxiliaries, piping, etc. The first boiler was put into service in May, 1937, the second two months later. The turbine was not ready for operation until September and the boilers were used in this interval to supply steam to the low pressure station through the reducing valve and desuperheater station. In the exterior photograph the new top addition is at the right hand side of the plant.

	1937		1938		1939		1940 (4 Mo.)		Installation to May 1, 1940	
	Operated	Available	Operated	Available	Operated	Available	Operated	Available	Operated	Available
	%	%	%	%	%	%	%	%	%	%
No. 7 Turbo-Gen.	68.8	97.3	87.6	88.3	95.5	96.4	98.1	100	89.8	93.9
No. 7-1 Boiler	56.5	71.7	82.9	86.6	88.3	88.3	95.0	95.0	80.2	84.8
No. 7-2 Boiler	68.8	79.1	78.8	83.6	90.9	90.9	97.5	97.5	83.9	87.2

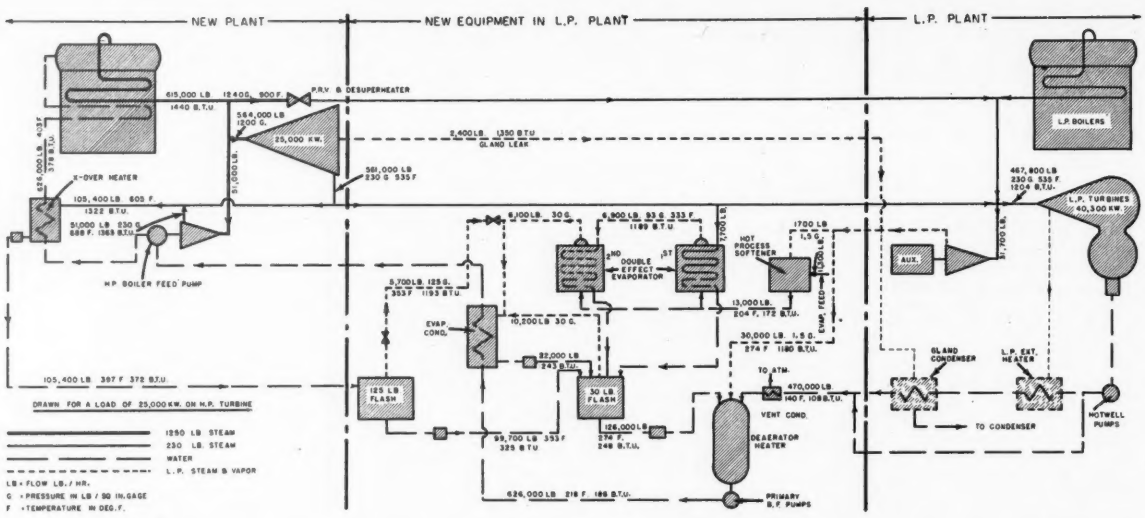
NEW PLANT
NEW EQUIPMENT IN L.P. PLANT
L.P. PLANT
P.R.V. & DESUPERHEATER
615,000 LB 1240 G. 900 F. 1440 B.T.U.
564,000 LB 1200 G.
25,000 KW.
2,400 LB. 1350 B.T.U. GLAND LEAK
561,000 LB 230 G. 535 F.
X-OVER HEATER
105,400 LB. 605 F. 1322 B.T.U.
51,000 LB 230 G. 668 F. 1368 B.T.U.
H.P. BOILER FEED PUMP
L.P. BOILERS
467,800 LB 230 G. 535 F. 1204 B.T.U.
L.P. TURBINES 40,300 KW.
AUX.
6,100 LB. 30 G.
6,900 LB. 93 G. 333 F. 1189 B.T.U.
2ND
1ST
DOUBLE EFFECT EVAPORATOR
HOT PROCESS SOFTENER
1700 LB 1.5 G.
5,700 LB. 125 G. 353 F. 1193 B.T.U.
EVAP. COND.
10,200 LB 30 G.
13,000 LB. 204 F. 172 B.T.U.
EVAP. FEED
30,000 LB. 1.5 G. 274 F. 1180 B.T.U.
22,000 LB 243 B.T.U.
105,400 LB. 367 F. 372 B.T.U.
125 LB FLASH
30 LB FLASH
TO ATM.
470,000 LB 140 F. 108 B.T.U.
VENT COND.
GLAND CONDENSER
L.P. EXT. HEATER
TO CONDENSER
HOTWELL PUMPS
DEAERATOR HEATER
99,700 LB 333 F 325 B.T.U.
126,000 LB 274 F. 248 B.T.U.
624,000 LB 218 F. 186 B.T.U.
PRIMARY B.F. PUMPS
DRAWN FOR A LOAD OF 25,000 KW. ON H.P. TURBINE
1250 LB STEAM
230 LB STEAM
WATER
L.P. STEAM & VAPOR
LB = FLOW LB./HR.
G = PRESSURE IN LB/SQ IN. GAGE
F = TEMPERATURE IN DEG. F.

Fig. 3. The heat balance of one top unit for a load of 25,000 kw. The top turbine exhausts at 230 lb. to the low pressure plant header in parallel with low pressure boilers. When Unit No. 8 is completed the low pressure boilers will not be needed, for each top unit at full load will carry about 45,000 kw. on the low pressure machines. The gland condenser shown dotted in the lower right hand corner was recently cut out of service and the gland steam cut into the low pressure auxiliary exhaust system. The low pressure extraction heaters, also shown dotted, are installed on only two low pressure turbines, one 20,000 and one 25,000 kw. unit. Condensate from the low pressure units may or may not pass through these heaters, depending upon which turbines are in operation so that the temperature to the deareating heaters may range from a maximum of 160 deg. F. to somewhat below the 140 deg. F. shown above

With the exception of the boilers, turbines, feed pumps and necessary auxiliaries, the only other equipment in the new section consists of the desuperheater stations and the high pressure or crossover heaters which are below the respective turbines. The desuperheater for No. 7 boilers as in the basement but steam piping arrangement made it advisable to install the No. 8 desuperheater above the operating floor. One of the No. 7 feed pumps is driven by a 230 lb. turbine which exhausts to the original station auxiliary exhaust system supplying the deaerating heaters. The other two are driven by 1200 lb. turbines which exhaust at 230 lb. and supply most of the steam needed by the crossover heater inasmuch as the exhaust from these units is at a higher temperature than that from the main turbines. Heater steam requirements beyond this are supplied from the regular 230 lb. system from a point near the desuperheater outlet. For Unit No. 8 all three feed pump turbines operate at 1200 lb. steam.

Evaporators, evaporator condenser, deaerating heaters and flash tanks, shown by the heat balance diagram Fig. 3, are all located in the low pressure turbine room. Details of these and other pieces of equipment are given in Table II. The cycle is simple, the low pressure turbine hotwell pumps, pump to the deaerating heater. Here it is picked up by the low pressure boiler feed pumps and pumped through the evaporator condenser to the secondary or high pressure boiler feed pumps which pump through the crossover heater and economizers to the boilers. Makeup treated in a hot process softener is evaporated, condensed and drained to the deaerating heater through a flash tank.

Application of the combustion control to the boilers is shown in diagrammatic form in Fig. 6. A master controller for the boiler room is connected to the main steam header and regulates a master air loading pressure for application to the controlled boilers. This master air loading pressure is applied to diaphragms of a boiler air flow controller and three primary air controllers on each boiler.

Air supply for the control is taken from the station compressed air supply to a receiving tank through a check valve and an air filter. The check valve serves to prevent immediate loss of control air if the station supply fails. Storage space in the receiving tank will run the control for approximately 30 minutes and, if the supply is not restored, a pressure interlock functions to disconnect all automatic control. The boilers on control will continue at the same rating as when the failure occurred until changed manually by the operator through the push button control.

Coal Storage and Electrical Changes

Ample space is available adjacent to the station for coal storage but it is necessary to store only some 60,000 t. at the present time. Originally this coal was stored and reclaimed by a locomotive crane but in 1937 the tracks were removed and storage and reclaiming is now done by a bulldozer. This method of storing and packing in layers has practically eliminated coal pile fires. For the new plant a 150 t. per hr. coal handling system consisting of a track hopper, skip hoist, cross and distribution belt conveyors were installed.

To tie in with the new plant rather extensive changes were necessary in the electrical end of the original station. Four of the low pressure units feed into a 6900 v. station bus. The auxiliary power is supplied from 12,000 v. busses through transformers at 440 v. In the new plant all electrically driven auxiliaries are of the 440 v., squirrel cage, line start type, supplied through three new 3750 kv-a., 3 ph., 6900/460 v. transformers. The new

auxiliary switchboard, divided into 6 sections by sectionalizing breakers, is of the self supporting dead front type, totally enclosed with air circuit breakers. It is located back of boilers No. 7-1 and 7-2 as shown by Fig. 2 and is connected with the old auxiliary switchboard by a tie line.

Half of the 6900 v. feeders were converted to 12,000 v. when a new 12,000 v. metal clad bus was installed. The 20,000 kw., low pressure No. 5 unit was reconnected for 12,000 v. and together with the new top turbines feed this bus directly. The 25,000 kw. low pressure Unit No. 6 was reconnected for 13,200 v. and feeds the same bus through a 13,200/12,000 v. autotransformer. Control of all generators as well as the 66 kv. high lines is now centralized in a seven section steel control desk which replaced the old marble bench board in the control room adjoining the low pressure turbine room.

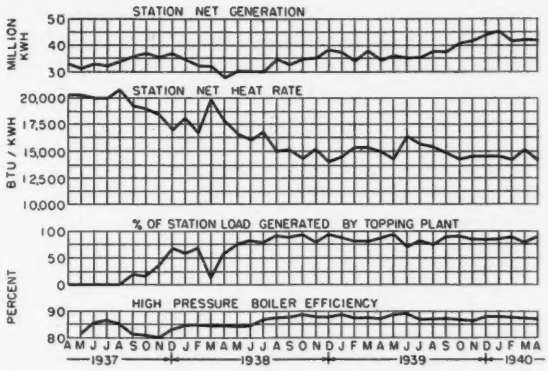

Fig. 5. Summary of the net station generation, station heat rate, portion of load generated by the top plant and pressure boiler efficiency for a 3 yr. period

Initial Operation

One of the boilers was placed in operation in May 1937; the other in July and the turbine in September so that high pressure steam generated during the first few months was bypassed to the low pressure system through the reducing valve and desuperheater station. From an operating standpoint, therefore, this article deals primarily with the years 1937 and 1938, for the latter part of 1937 was spent largely in ironing out wrinkles, which will be discussed later, and 1940 is just getting under way. Of the early troubles encountered none could be charged against operating personnel, although none had previous experience with either high pressure or pulverized coal installations. This success should properly be attributed to careful training and supervision.

Because it can be covered briefly and its performance adequately described by a single word—satisfactory—the turbo-generator unit will be discussed first. Articles[2],[3], written at the time the unit was being installed in 1937 listed its rating at 25,000 kw. at 0.80 p.f. At that time it was expected that the generator would be air-cooled. Before assembly was started in the field, hydrogen-cooling was decided upon and after a period of preliminary operation, the unit rating was changed to 30,000 kw. at 0.90 p.f.

The satisfactory performance has been due in a large measure to the manufacturers anticipating

[2]Millers Ford Topping Unit Improves Station Efficiency. Electric Light & Power, March 1938.
[3]Topping Millers Ford and Millers Ford—Build to Run, Power, May 1936 and June 1938.

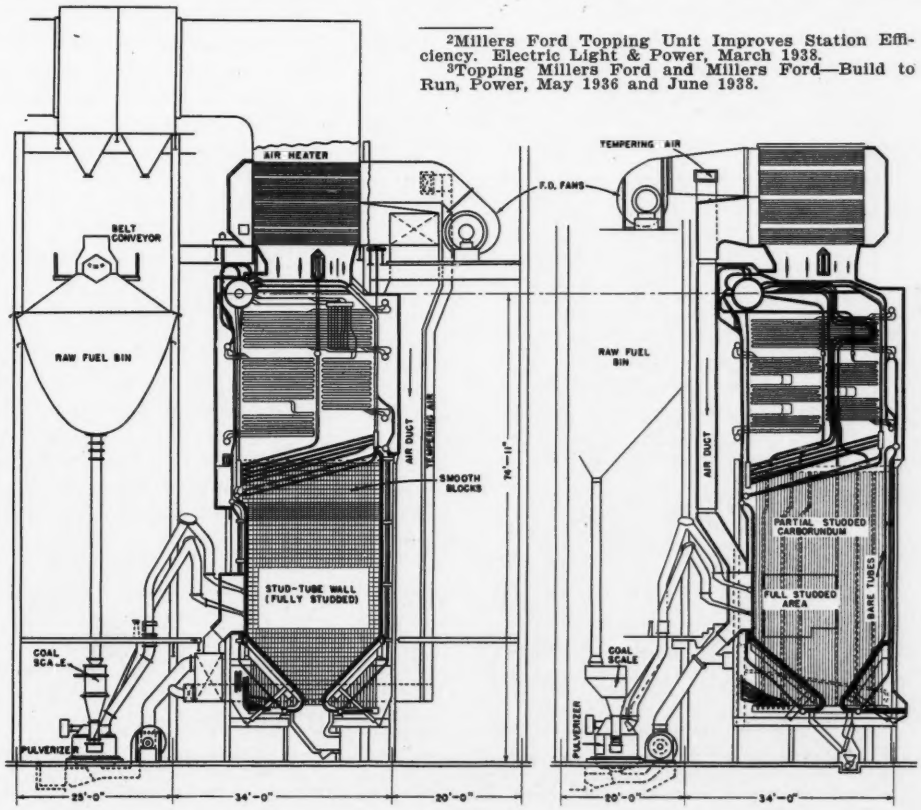

Fig. 4. The two new boilers (right) are practically duplicates of the original two (left), the principal difference being additional bare wall surface in the furnace and the arrangement of the fans and ducts. A detailed listing of the various heating surfaces is given in Table II

trouble before it occurred and forestalling it by preventative action. This, of course, required some outages, but of the three major turbine outages, only one was forced, by the failure of a shroud band on the first stage wheel in February, 1938. The first, second and third stage wheels and diaphragms were rebladed, although blades in the latter two had only slight dents. The failure caused no noticeable change in the operation of the turbine itself and was detected only by the change in first stage pressure readings. At this time a slight blade deposit of a siliceous nature, resulting from a feedwater condition discussed later, was discovered.

Soon after this outage the cover was again lifted to inspect the blading. Nothing was amiss, so the turbine was placed in service but operated at reduced pressure during light load periods. This inspection and operation was at the request of the manufacturer due to conditions that had arisen on another turbine of similar design. After reduced pressure operation for but a short time, normal operation was resumed without further incident. As part of this same precautionary move the cams operating the admission valves were changed so that at light loads the opening of the valves would overlap more than before.

The third major outage was scheduled for the late summer of 1939 to install a new rotor with an improved type of first stage blading and shroud band. The old rotor was changed to include this feature and will be installed in No. 8 turbine. This changed design obviates the necessity for cams now in use on No. 7 turbine, consequently, No. 8 will have cams identical with those originally installed on No. 7 and the original cams will be replaced on the latter as soon as No. 8 is available for service.

All other outages have been of a minor nature, most of them being accounted for by bringing a boiler on. This is a simple precaution that has been taken inasmuch as the piping arrangement

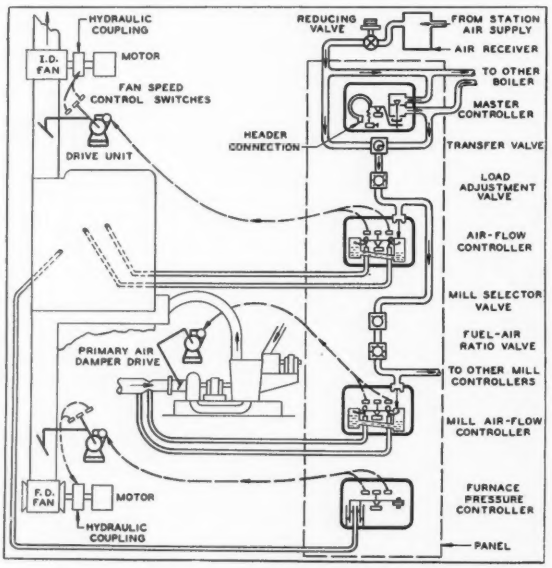

Fig. 6. Diagrammatic arrangement of the combustion control system. Steam temperature is also automatically controlled, both from the top turbine exhaust temperature and from the superheater outlet

Fig. 7. View looking between Boilers Nos. 7-1 and 7-2 with the boiler panels on either side and the auxiliary switchboard in the background

is such that one boiler cannot deliver steam to the reducing valve independent of the other boiler. Provision to do this will be made in the No. 8 addition.

Governor and Hydrogen

Although installed, the back-pressure governor has never been used on No. 7 unit for it was not deemed advisable to inject factors into the operating procedure unless absolutely necessary. Present practice calls for the switchboard operator to regulate the exhaust pressure by manually adjusting the load on No. 7 unit up to 25,000 kw. By that time sufficient low pressure boilers are in service to handle the regulation. This procedure is reversed for a decreasing load. How the back pressure will be regulated when No. 8 unit is in service is a matter yet to be determined.

The main generator was operated initially for about two weeks with air cooling before being shut down and the necessary hydrogen control equipment was installed and it has the distinction of being the first commercial installation of this kind in the world. In the ensuing 2.5 yr. the hydrogen and its control[4] have not developed a single complication. A solenoid gas-admission valve and pressure-control switch, a hydrogen purity indicator, fan-pressure gage and other indicating instruments required for the operation of the generator in hydrogen are housed in a compact control cabinet located near the generator. An alarm system is provided in the cabinet which, through the operation of signal lamps and a horn, notifies the operator of abnormal conditions in either the shaft-sealing or the hydrogen-control system.

Consumption of gas has averaged about 800 cu. ft. per month, accounted for by the "breathing" due to changes in winding temperatures during the daily load cycle and the loss in the sealing oil. The use of hydrogen instead of air reduced the no-load steam consumption 20 per cent but most of this gain was lost when the new turbine valve cams, mentioned earlier, were installed. This will be adjusted when

[4]Hydrogen Cooled Generators. Power Plant Engineering, p. 93 April 1940.

Continued on Page 52

Experimental verification of the effect of vibration on increasing heat transfer led to the further investigation of the effect which might be expected from amplitudes and frequencies found in ordinary power plant service.

VIBRATION— Its Effect on Heat Transfer

By W. E. MASON* and
L. M. K. BOELTER**

VIBRATION is usually considered an unavoidable evil, to be decreased or absorbed as much as possible and then endured. Vibration which may produce fatigue failure, either in the machine itself or in its connected piping and auxiliaries must be eliminated. Mechanical equipment in churches, schools, theatres, office buildings and homes must be especially quiet and free from vibration.

In the factory and power plant, however, efficiency and safety are of primary importance and a moderate amount of noise and vibration may not be objectionable. Designers of heat transfer apparatus for such plants are aware of the fact that the equipment may be subjected to vibration. The question then arises as to the effect of such vibration on the rate of heat transfer. With this question the following discussion particularly deals.

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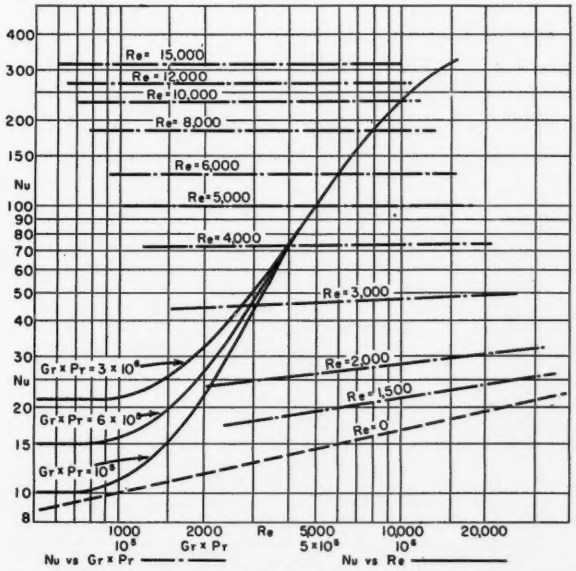

Fig. 1. The relation of Grashop's, Prandl's, Nusselt's and Reynolds' moduli to heat transfer of a vibrating tube

Vibration of rotating and reciprocating machinery such as engines, turbines and motors may be due to initial unbalance arising from faulty design or workmanship, to uneven wear, stripping of blades, deposits left on blading from the steam, wear of the packing ring, loose foundation and coupling bolts, foundations of too little mass[1], excessive bearing clearance[2], and in some cases be due to incorrect steam piping layout[3].

Causes of Vibration in Power Plants

The great majority of cases of excess vibration of boilers are due to poor piping layout and careless workmanship[4, 5]. The high gas velocities in the modern oil, gas, and pulverized coal fired boilers also contribute to the vibration problem.

Condenser tubes possess natural frequencies of vibration depending on their size, weight, length between supports, and the method of support[6]. Vibration may be transmitted to them or may be caused by the steam flowing over them.

Vibration in piping may be received from connected machinery or may be produced by incorrectly designed bends and elbows[7, 8].

Effect on Heat Transfer

The rate of heat transfer to water from horizontal tubes vibrated in a vertical plane, has been determined experimentally. The first series of experiments[9] included amplitudes of vibration up to 0.1 in. and frequencies up to nearly 40 c.p.s., on a 0.75-in. diameter tube. Subsequent tests have covered am-

[1]Phillips, M., Stopping Vibration in Steam Turbines, Power Plant Engineering, Vol. 36, pp. 810-811, Dec., 1932.
[2]Geddes, G. E., Vibration in Turbines, Power Plant Engineering Vol. 37, p. 224, May, 1933.
[3]Vandegraft, W. A., Incorrect Steam Piping Layout Causes Excessive Turbine Vibration, Power, Vol. 64, p. 343, Aug. 31, 1926.
[4]Brown, M. M., Causes of Boiler Vibration, Power, Vol. 55, pp. 983-984, June 20, 1922.
[5]Brennan, J. M., Causes of Pulsations in Furnaces and Vibrations in Boilers, Power, Vol. 67, pp. 619-620, May 22, 1928.
[6]Warner, W. E., Condenser Tube Vibration, Power, Vol. 61, p. 38, Jan. 3, 1925.
[7]Dixon, A. J., Cause of Vibrations in Steam Pipes, Power, Vol. 55, p. 472, March 21, 1922.
[8]Hobart, J. F., Elbows Cause Vibration in Steam Plants, Power Plant Engineering, Vol. 33, p. 197, Feb. 1, 1929.
[9]Martinelli, R. C. and Boelter, L. M. K., The Effect of Vibration on Heat Transfer by Free Convection from a Horizontal Cylinder, (Proceedings of the Fifth International Congress of Applied Mechanics, Cambridge, Massachusetts), 1938, p. 578. John Wiley and Sons, 1939.

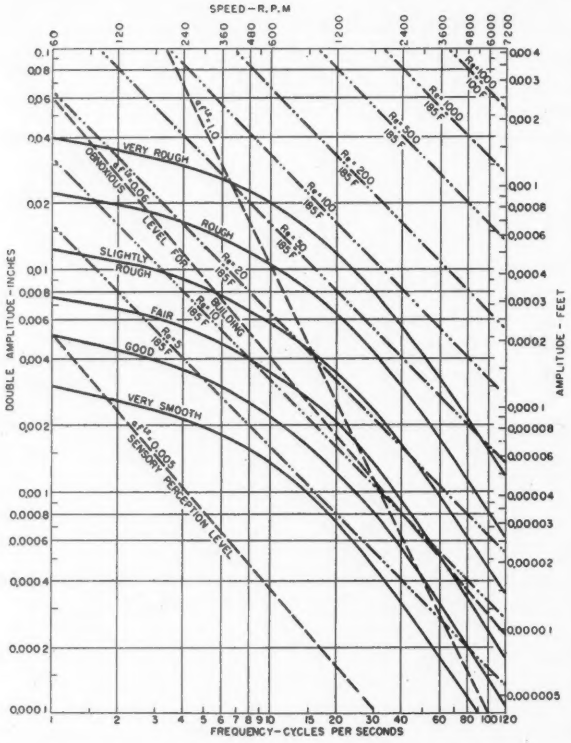

Fig. 2. Machinery Vibration Tolerance with the excitation frequency equal to speed of the source and corresponding Reynolds' Modulus for water as 100 and 185 deg. F. arithmetic mean

plitudes up to 0.26 in. with tubes 0.375, 0.75 and 1.25 in. in diam. Temperature differences between the tube surface and the surrounding water have been varied from 0.56 to 50 deg. F.

A modified Reynolds' modulus (Re), using the root mean square velocity of the vibrating tube instead of the commonly used linear velocity of the vibrating tube, has been used in correlating the experimental results with the boundary modulus Nu (Nusselt). Magnitudes of "Re" have been varied from 0 to 15,000 while Nu-(fd/k) increased from 15.7 for free convection (no vibration) to 315 for Re = 15,000. The unit thermal conductance "f" is proportional to the rate of heat transfer and for a given fluid and tube diameter is the significant variable in Nusselt's modulus. Increase of the unit thermal conductance appears to be a function of amplitude times frequency, that is, of Reynolds' modulus, Re. Grashof's modulus times Prandl's modulus, enters the correlation due to the importance of free convection when the tube is vibrated slowly. All of these moduli are completely defined at the end of this article. The dot-dash lines in Fig. 1 reveal the general effect of Gr. x Pr. on Nu for various values of Re and the solid lines which are a cross-lot of the above, indicate the relationship between Nu and Re for designated values of Gr. x Pr.

[10]Rathbone, T. C., Vibration Tolerance, Power Plant Engineering, Vol. 43, pp. 721-724, Nov., 1939.

[11]Martinelli, R. C. and Boelter, L. M. K., The Effect of Vibration Upon Free Convection from Horizontal Cylinders, A. S. H. & V. E. Journal Section, Heating, Piping, and Air Conditioning, Vol. 11, No. 8, pp. 525-527, Aug., 1939.

The significant fact to be noted from Fig. 2 is that the rate of heat transfer from a tube to water has been increased more than thirty fold for a magnitude of Gr. x Pr. of 1 x 10^5 and eighteen fold for Gr. x Pr. = 1 x 10^6, through the medium of vibration alone. The present experimental apparatus has not permitted further increase in Re, but the change in slope in the upper range indicates that probably not much increase in unit thermal conductance is to be expected with higher magnitudes of Reynolds' modulus. There exists also a lower limit of Re, below which vibration has no appreciable effect on Nu. This lower limit is approximately Re = 1000, for Gr. x Pr. = 3 x 10^6.

Effect in Normal Service

It is important to determine whether magnitudes of vibration such as could be safely and comfortably permitted in a power plant will be sufficient to produce an increase in the rate of heat transfer by free convection; i. e., whether they will exceed Re = 1000. Rathbone[10] and Karelitz have given us an index of machinery vibration tolerance. Figure 2 is a reproduction of their chart with corresponding values of Re added, these values being based on assumed arithmetic mean fluid temperature of 185 and 100 deg. F. and an outside diameter of heater tube of 0.75 in. It appears that 1.25 would be the magnitude of Re produced by vibrations at the sensory perception level, 15 to 75 for very rough operation and 10 as objectionable from the standpoint of the building. If the temperature of the water were increased from 100 to 185 deg. F., the above values of Re would be increased to values 2.0 times as large, or a maximum of 150 for very rough operation. If at the same time the diameter

Continued on Page 68

DIMENSIONLESS MODULI.

All fluid properties are evaluated at arithmetic mean temperature of tube and fluid far away and not affected by the heat transfer from the vibrating tube

$$Re = \frac{a\omega d\rho}{\sqrt{2}\,\mu}$$ — Reynolds' Modulus.

$Nu = fd/k$ — Nusselt's Modulus.

$$Gr. = \frac{d^3\rho^2 g\beta\Delta T}{\mu^2}$$ — Grashof's Modulus.

$$Pr. = \frac{\mu c_F g}{3600k}$$ — Prandl's Modulus (equal to the reciprocal of Stanton's Modulus, Sa.)

$$Gr.\ x\ Pr. = \frac{d^3\beta\Delta t\rho^2 g^2 c_F}{3600k}$$

a = amplitude of vibration in feet. (This is ordinarily half of the total movement.)

ω = angular velocity in radians per second = 2π times the frequency in cycles per second.

d = diameter of the tube in feet.

ρ = mass density, lb. sec.^{2}/ft.^{4}.

g = acceleration of gravity = 32.2 ft./sec.^{2} (approx.)

μ = viscosity, lb. sec. per ft.^{2} = centipoises x 0.000672/g.

f = unit thermal conductance, B.t.u./ft.^{2}hr. deg. F.

k = thermal conductivity, B.t.u./ft.^{2}hr. (deg. F./ft.).

Δt = temperature difference between tube surface and surrounding liquid in deg. F.

β = expansion coefficient, defined as the volume change of a unit volume per unit temperature at constant pressure. Its dimensions are (deg. F.).$^{-1}$

c_F = unit heat capacity of liquid in B.t.u./lb. deg. F.

Part I. By the use of the molar system the theoretical results of the combustion of a solid fuel are worked out in an example which explains the method now commonly employed. In the second installment of this two-part series, the author will apply the method to gaseous fuel.

Notes on Combustion Calculations

BY C. W. MESSERSMITH

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COMBUSTION may be defined as the combination of a substance with oxygen at a sufficiently rapid rate to cause the resulting products to have a relatively high temperature. Carbon (C) and hydrogen (H_2), either free or combined, constitute the greater part of the combustible substance of most fuels. Sulphur (S) is found in many fuels, but although it contributes to the energy content (heating value) it is objectionable because of operating difficulties caused by the SO_2 formed when it burns.

It is important to be able to predict the amount of air required or the amount and composition of the resulting products of combustion when a given fuel is burned under specified conditions. The term "Theoretical Combustion" is generally applied to calculations of this nature. The term "Actual Combustion" is used for problems involving determination of the air supplied, and the products obtained, when a fuel is burned under actual operating conditions as in an internal combustion engine or the furnace of a steam generating unit.

All combustion calculations are based on the fundamental equations representing chemical reactions which involve the combination of molecules. The molar system will therefore be used for all preliminary computations. Subsequent conversion to weight or volumetric basis is made as desired.

The pound-mol (hereinafter designated as the mol) is defined as the weight of a substance in pounds equal to the molecular weight of that substance. Thus, one mol of carbon (C) weighs 12 lb, one mol of hydrogen (H_2) 2 lb,* etc. Since at a given pressure and temperature equal volumes of gases contain the same number of molecules, it follows that the weights of such equal volumes are proportional to the molecular weight. This relationship provides a very useful means of changing from a weight or gravimetric basis to a volumetric basis (or vice versa) where gases are involved.

Theoretical Combustion Problems

The fuel analysis forms the starting point for problems of this type. This analysis is given on a weight basis for liquid and solid fuels and usually on a volumetric basis for gaseous fuels. It may be noted at this point that most liquid fuels used are mixtures of a very large number of different hydrocarbon molecules and that it is common practice to assume that the fuel is composed of a single kind of molecule which has, approximately, the average molecular weight and hydrogen-carbon ratio of the actual fuel.

A clear understanding of the fundamentals involved can best be secured by the use of typical examples.

Problem for Solid Fuel

Assume that a solid fuel such as the bituminous coal of Table I (columns 1 and 2), is to be burned with 50 per cent excess air and that the following items are to be determined:

(a) Pounds of air required per pound of fuel.
(b) Volume of air in cu. ft. per pound of fuel. (14.7 lb. per sq. in. abs., 90 deg. F.)
(c) Weight of CO_2 formed in pounds per pound of fuel.
(d) Volume of N_2 in products of combustion in cu. ft. per pound of fuel. (14.7 lb. per sq. in. abs. and 400 deg. F.).
(e) Volumetric analysis of the dry gaseous products of combustion.
(f) Apparent molecular weight of the products of combustion.
(g) Gas constant of the products of combustion.

Solution: General—Before determining any of the specific items listed above, certain pertinent remarks and basic calculations will be made. These basic calculations will be made for 100 lb. of fuel. Referring to column 2, it should be noted that the values in pounds per hundred pounds of coal are also the percentages of the various constituents by weight. It should be further noted that the summation of column 2 gives 100 lb. which indicates that the free moisture (12.61 per cent for this fuel) is included in the hydrogen and oxygen. With the exception of calculations for heating value of the fuel and certain items in the heat balance, it makes no difference whether the moisture is listed as a

*Approximate whole-number atomic weights are sufficiently accurate for most combustion problems. Accurate values may be found in many texts and handbooks.

separate item or not. It is suggested that the reader change the analysis to a "moisture separate" basis and follow through the problem to see that the same ultimate results will be obtained regardless of which basis is given for the analysis.

The first step is to convert the weight analysis in pounds per hundred pounds of fuel to mols per hundred pounds of fuel. This is accomplished by dividing the weight of each item by the weight of one mol. Thus (65.65 lb. C/100 lb. fuel) ÷ (12 lb. C/mol C) = 5.47 mols C/100 lb. fuel. Column 3 shows the weight per mol of each constituent. Dividing the values in column 2 by those in column 3 gives the mols per hundred pounds of fuel as found in column 4.

Column 5 lists the reactions occurring between the combustible substances and oxygen. Line 1 shows that one mol of C unites with one mol of O_2 to produce one mol of CO_2. In this problem, there are 5.47 mols of C which will require 5.47 mols of O_2 and will produce 5.47 mols of CO_2. It should be noted at this point that if the 5.47 mols of O_2 are supplied wholly from the air, a certain amount of N_2 will accompany the O_2 and will appear in the products of combustion. The amount of N_2 is best calculated after the total O_2 required has been determined and corrected for the O_2 accompanying the fuel. Thus the net O_2 from the air supplied for combustion will be used as the basis for calculating the N_2 from the air which appears in the flue gases.

Line 2 shows that:—

2 mols H_2 + 1 mol O_2 gives 2 mols H_2O.

Therefore 2.94 mols H_2 will require 2.94 × 1 mol O_2 ÷ 2 mols H_2 = 1.47 mols O_2 as shown in column 6; and will produce 2.94 × 2 mol H_2O ÷ 2 mol H_2 = 2.94 mols H_2O as found in column 8. Although some writers object to the procedure, the writer prefers to divide through the reaction equation by the coefficient of the combustible substance, obtaining in this case 1 mol H_2 + ½ mol O_2 gives 1 mol H_2O. In this equation the coefficients of the O_2 and the H_2O become the multiplying factors for the number of mols of H_2 actually present in the fuel under consideration. In fact, it has been found that the use of this method reduces the probability of making subsequent errors.

There are 0.58 mols of O_2 in the fuel (Line 3). Obviously this oxygen is available to unite with one or more of the combustible substances and will therefore reduce the amount of oxygen required from the air. It is therefore entered in column 6 as a negative amount.

Line 4 shows that the 0.053 mols of nitrogen, being inert, simply appear in the products of combustion. In dealing with solid fuels, this value is relatively so small that it may be satisfactorily neglected. It will be included in this problem, however, for purposes of illustration.

Lines 5 and 6 need no explanation other than to note that while the ash is a product of combustion, it is a solid and does not enter into any of the subsequent calculations.

Addition of column 6 shows that 6.407 mols of O_2 will be required from the air. As previously noted, all O_2 from the air will be accompanied by N_2 (neglecting the small amounts of other gases in air). For calculations of this nature, air is assumed to be composed of 20.91 per cent O_2 and 79.09 per cent N_2 by volume or 23.1 per cent O_2 and 76.9 per cent N_2 by weight. The following relations, based on these percentage compositions, will be found quite useful:

By volume:

1 volume O_2 + 3.78 volumes N_2 = 4.78 volumes Air (1)

By weight:

1 lb. O_2 + 3.32 lb. N_2 = 4.32 lb. Air (2)

1 mol air = 28.94 lb. Air (3)

Since the mol is a unit of volume (for gases only), one mol O_2 + 3.78 mols N_2 = 4.78 mols Air. Therefore 6.407 mols of O_2 will be accompanied by 6.407 × 3.78 = 24.218 mols of N_2. This result is shown in line 7.

Line 8 gives the results in mols per 100 lb. of fuel if the fuel is burned with the chemically correct amount of air. This would be perfect combustion and is so designated in line 8. In practice it is not possible to have perfect combustion; and generally an excess of air is supplied. This problem specified 50 per cent excess air, which simply means that 50 per cent more O_2 will be supplied from the air than is required for perfect combustion. This excess O_2 (0.5 × 6.407 = 3.203 mols) will be accompanied by 3.203 × 3.78 (or 0.5 × 24.218) = 12.109 mols of N_2. All of the excess O_2 will appear in the products since it is not needed to complete the reactions. The results with excess air are given in line 10.

Now that all basic calculations have been made, the specific requirements of the problem can be completed. The reader should note what part of the calculations of Table I is necessary for each of the requirements, e.g., only the values shown in column 6 would be needed for the solution of part (a).

(a) Pounds of air required per pound of fuel. (9.61 mols O_2/100 lb. fuel × 32 lb. O_2/mol O_2 × 4.32 lb. air/lb. O_2 in air) ÷ 100 = 13.29 lb. of air per lb. of fuel.

or (9.61 mols O_2/100 lb. fuel × 4.78 mols air/mol O_2 × 28.94 lb. air/mol air) ÷ 100 = 13.29 lb. of air per lb. of fuel.

(b) Volume of air in cu. ft. per pound of fuel. (14.7 lb. per sq. in. abs., 90 deg. F.)

Using the results of (a)

$$V = \frac{wRT}{P} = \frac{13.29 \times 53.3 \times 550}{14.7 \times 144} = 184 \text{ cu. ft.}$$

This might be solved independently of part (a) as follows:

The volume of one mol of any gas at 14.7 lb. per sq. in. abs., and 90 deg. F. will be

$$V_m = \frac{1544T}{P} = \frac{1544 \times 550}{14.7 \times 144} = 400 \text{ cu. ft.}$$

and since 9.610 × 4.78 = 45.9 mols of air are required per 100 lb. of fuel, the volume of air required will be (400 × 45.9) ÷ 100 = 184 cu. ft.

TABLE I. Fuel Analysis Given on Weight Basis

Line	Constituent	Pound/ 100 Pounds coal	Pound/ Mol.	Mols/ 100 Pounds coal	REACTION	MOLS PER 100 LB. COAL					
						O_2 Reqd. from air	Products of Combustion (Gaseous)				
							CO_2	H_2O	SO_2	N_2	O_2
	1	2	3	4	5	6	7	8	9	10	11
1	C	65.65	12	5.47	$C+O_2=CO_2$ 1 mol+1 mol=1 mol	5.47	5.47				
2	H_2	5.87	2	2.94	$2H_2+O_2=2H_2O$ 2 mols+1 mol=2 mol	1.47		2.94			
3	O_2	18.61	32	0.58		—0.58					
4	N_2	1.48	28	0.053						0.053	
5	S	1.51	32	0.047	$S+O_2=SO_2$ 1 mol+1 mol=1 mol	0.047			0.047		
6	Ash	6.88	..	....							
7	O_2 and N_2 from air					6.407				24.218	
8	Results for perfect combustion (mols/100 lb. coal)					6.407	5.47	2.94	0.047	24.271	None
9	Additional O_2 & N_2 with 50% excess air					3.203				12.109	3.203
10	Results for combustion with 50% excess air					9.610	5.47	2.94	0.047	36.380	3.203

(c) Weight of CO_2 formed in pounds per pound of fuel.

According to column 7 line 10, 5.47 mols of CO_2 are formed per 100 lb. of fuel. Each mol of CO_2 contains 12 lb. of C and 32 lb. of O_2 making 44 lb. in all.

Then, (5.47 mols CO_2/100 lb. fuel $\times$ 44 lb. CO_2/mol CO_2) $\div$ 100 = 2.407 lb. CO_2/lb. fuel.

Obviously, the corresponding value of any other constituent of the products of combustion can be determined in a similar manner.

(d) Volume of N_2 in products of combustion in cubic feet per pound of fuel.

The volume of one mol of any gas at this pressure and temperature would be:

$$V_m = \frac{1544T}{P} = \frac{1544 \times 860}{14.7 \times 144} = 627 \text{ cu. ft./mol.}$$

The value required would then be (627 cu. ft./mol $\times$ 36.38 mols N_2/100 lb. fuel) $\div$ 100 = 228 cu. ft. N_2 in products of combustion per pound of fuel.

This value might also be determined by finding the pounds of N_2 per pound of fuel (as in part c), and determining the volume by the use of $PV = wRT$ where R is the gas constant for N_2.

(e) Volumetric analysis of the dry gaseous products of combustion.

The advantage of the use of the molar system is particularly evident in the solution of this item. Recalling the fact that for gases the mol is a measure of volume as well as weight, it may be said that the products of combustion consist of 5.47 volumes of CO_2, 0.047 volumes SO_2, 36.38 volumes N_2, and 3.203 volumes of O_2, making a total of 45.1 volumes. (The term "volumes" is here used to represent any convenient unit of volumetric measurement). Therefore, the CO_2 will be $\frac{5.47}{45.1} \times 100 = 12.13$ per cent; and similarly the SO_2 is found to be 0.1 per cent, the N_2 80.66 per cent, and the O_2 7.11 per cent.

The same results might be obtained by finding the cubic feet of each constituent per pound of fuel (as in part d), but the time required would be increased considerably.

(f) Apparent molecular weight of the products of combustion.

The calculation of this item involves simply the determination of the weight of each constituent present in one mol of the mixture. Thus:

5.47	mols	$CO_2 \times 44$ lb./mol. =	240.7 lb. CO_2
2.94	mols	$H_2O \times 18$ lb./mol. =	52.9 lb. H_2O
0.047	mols	$SO_2 \times 64$ lb./mol. =	3.0 lb. SO_2
36.38	mols	$N_2 = 28$ lb./mol. =	1018.6 lb. N_2
3.203	mols	$O_2 = 32$ lb./mol. =	102.5 lb. O_2
48.040	mols (total) weight		1417.7 lb.

Therefore one mol weighs $\frac{1417.7}{48.04} = 29.5$ lb.

(g) Gas constant of the products of combustion.

The gas constant $R = \frac{1544}{\text{lb./mol}} = \frac{1544}{29.50} = 52.3$ ft.—lb./lb./°F.A.

(To be concluded)

CITIES sometimes have to dig down 3000 ft. for subterranean sources of water supply and frequently water and soil conditions are such that corrosion of pump and well equipment becomes a serious problem. A type of equipment has been developed which solves this problem by the use of a monel shutter screen at the bottom of the well. This screen won't rust and at the same time it disposes of the problem of sand infiltration.

"GOOD TO THE LAST

A short description of the steam generating plant of the new Maxwell House Plant of General Foods Corporation at Hoboken, N. J.

GEARED TO PRODUCE the equivalent of 1,500,000 cups of coffee per hour or 25,000 cups a minute, the new Maxwell House plant of General Foods Corporation at Hoboken is perhaps the largest of its kind in the world. This great plant, having some 500,000 sq. ft. (10 acres) of floor space, was designed, constructed and equipped by the H. K. Ferguson Co. of Cleveland, Ohio, in conjunction with owner's engineers and placed in operation last year. It forms an attractive group of buildings fronting on the Hudson River between 11th and 12th Streets in Hoboken.

The plant comprises several buildings. The main structure, the Maxwell House Coffee and Tea and the Sanka Coffee roasting plant is six stories high, facing on the river and having its piers and warehouse arrangements on the waterfront. The Central Research Laboratory of General Foods occupies another building. Then there is a new can manufacturing plant which occupies another building and finally the boiler plant with which this article is primarily concerned. The grounds surrounding the buildings have been landscaped so that the factory as a whole adds much to the appearance of upper Hoboken since the plant replaces old war time army warehouse shacks that occupied the site for almost two decades.

Electric power for lighting and operating the more than 600 motors in the plant is purchased so no generating equipment is provided, but since a considerable amount of steam is necessary for processing and in winter for heating the buildings, the

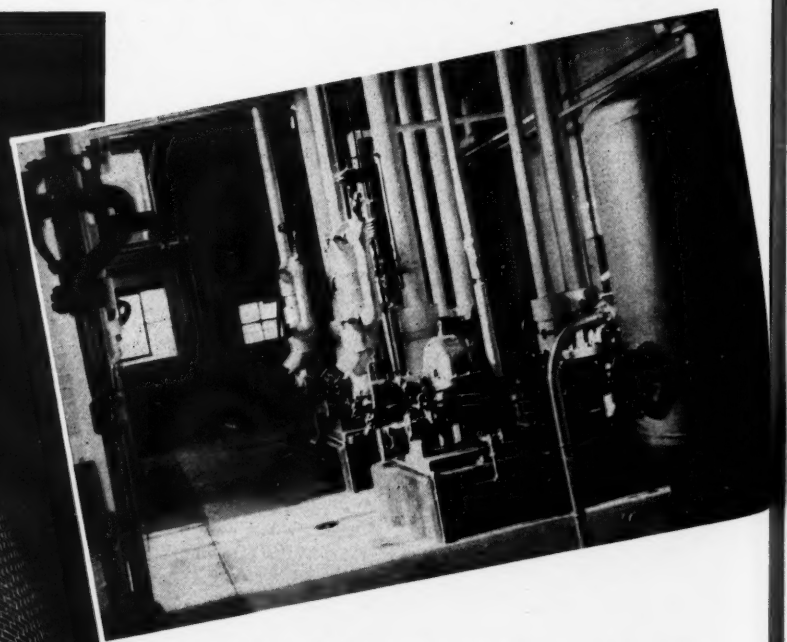


Fig. 1, (Left) The 192 ft. radial brick chimney for the Hoboken Plant of Maxwell House forms an interesting study in perspective. (Photo, Schmall)

Fig. 2 (Above) A view behind the boilers, showing the two boiler feed pumps and at the extreme right, the blow down tank

DROP"

Fig. 3 (Below) A view above the boilers showing the stairway to the platform on which the deaerating feed water heater is mounted

Fig 4 (Above) One of the burner platforms. Each boiler has three oil burners which are easily accessible from a small platform as shown (Photo, Schmall)

boiler plant is quite large. It contains two 35,000 lb. per hr. boilers together with the necessary auxiliaries and from a design standpoint is one of the lightest, cleanest and roomiest boiler plants we have ever seen. With practically everything inside painted in light colors or "aluminum," it was possible to take the accompanying photographs with instantaneous exposures without the aid of artificial lighting—a condition extremely rare in our experience in taking photographs in power plants.

While the engineering design throughout is of the highest character the plant layout is simple and requires little description. The two boilers are set side by side with the operating floor at grade level with the feedwater pumps, fuel oil pumps and heaters and feedwater heater at the rear of the boilers.

The boilers are Babcock & Wilcox Integral furnace units rated at 35,000 lb. per hr. capacity, designed for 400 lb. working pressure but operated at present at around 115 lb. They are oil fired, each furnace having three B. & W. steam-mechanical type oil burners installed in the front wall. A turbine driven forced draft fan is also fitted directly into the front wall of each furnace below the burners. Combustion is controlled automatically by Bailey control equipment. The control board, which also contains various recording and indicating instruments, is placed in front of and midway between the two boilers.

Fuel oil is delivered to the plant by barge or tanker and pumped into either of four storage tanks located adjacent to the boiler house. A fifth tank serves as a service tank from which the supply to the burners is taken. From the storage tanks the oil may be pumped into the service tank or directly to the boilers if desired. Transfer of oil from the storage to the service tanks is taken care of by either of two transfer pumps installed for that purpose.

Two fuel oil pumps deliver fuel to the burners. One of these is turbine driven through reducing

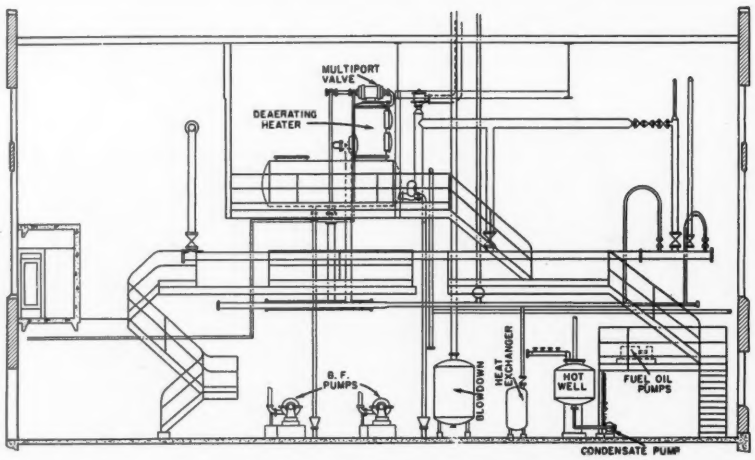


Fig. 5 (Left) An elevation of the equipment arranged along the rear wall of the boiler plant
Fig. 6 (Top, opposite p.) An aerial view of the Maxwell House Plant showing its location with respect to New York City on the other side of the Hudson River (Photo, Fairchild Aerial Surveys, Inc., N. Y.)
Fig. 7 (Center, opposite p.) A view from the top of one of the boilers showing the steam flow meter connections along the rear wall of the boiler house
Fig. 8 (Lower right, opposite p.) Looking down the operating aisle, showing the edge of the boiler control panel

gears while the other is motor driven. Normally the oil is heated to a temperature of around 205 degrees by three steam heat exchangers but an electric oil heater is also provided for use in starting up when no steam is available. The oil pressure carried on the burner lines is around 190 lb.

Feedwater is city water. This is heated in an Elliott deaerating heater and delivered into the boilers by either of two steam turbine driven pumps running at 3500 r.p.m. All condensate returns feed into a hotwell from which a small motor driven pump, pumps it into the feedwater heater. The latter is installed above the boiler near the rear wall of the room. The Hall system of feedwater treatment is used and a continuous blow down system maintains proper boiler water concentration at all times.

An interesting feature of the steam heating system is the method of temperature control which has been worked out. The temperature in the various buildings and in various rooms is controlled manually by means of air operated remote controlled reducing valves from the boiler control board. This method of control has been found very satisfactory. Ordinarily the temperature of the various buildings is regulated in accordance with the prevailing outside temperature but it can be adjusted to suit the desires or needs of the workers when necessary. From experience tables of steam pressure vs. outside temperature have been devised and the boiler room operator adjusts the steam pressure in the heating lines from these tables. In the office building, for example at 70 deg. outside temperature, the steam is turned off completely. At 60 deg. it is off or a pressure of 1 lb. is carried on order from the occupants. At 40 deg. a pressure of 2 lb. is maintained; at 25 deg. 5 lb. and so on up to 10 lb. at zero deg. and 12 lb. at ten below zero. This holds for the office building only. For the manufacturing buildings a slightly lower scale of pressures is carried since the workers in the factory in most instances are more active than office workers and also because heat from roasting ovens and other processes contributes to raise the temperature of the rooms.

As mentioned at the beginning of this article the plant is unusually clean and bright and there is an abundance of room. The atmosphere of spaci-

List of Principal Equipment in Maxwell House Plant

Location: Hoboken, N. J.
Type Plant: Boiler Plant, Medium Pressure.
Owners: General Foods Corp.
Engineers and Designers: H. K. Ferguson Co.

EQUIPMENT

BOILERS—2 integral furnace units designed for 400 lb. pressure. Capacity 35,000 lb. per hr. each. Babcock & Wilcox Co.

BURNERS—3 steam-mechanical oil burners for each boiler. Babcock & Wilcox Co.

FORCED DRAFT—1 steam turbine driven fan installed on each boiler furnace. L. J. Wing Mfg. Co.

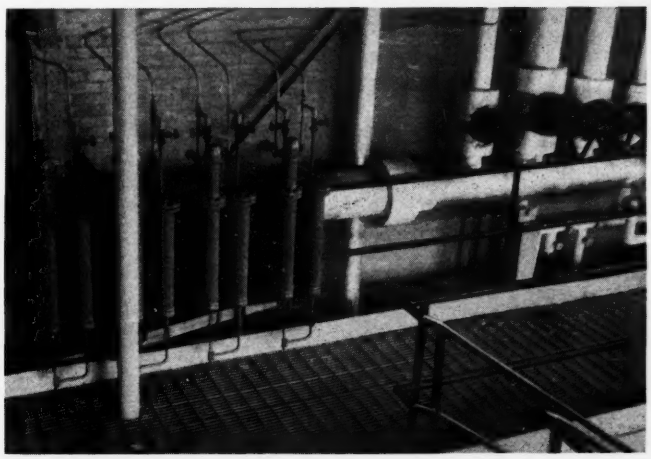
BOILER FITTINGS—
- Soot blowers. Diamond Power Specialty Co.
- Blow-off valves. Yarnall-Waring Co.
- Feedwater regulators. Bailey Meter Co.
- Safety valves. Manning, Maxwell & Moore, Inc.
- Stop valves. Edward Valve & Mfg. Co., Inc.
- Main steam header valves. Wm. Powell Co.
- Valves on line to soot blowers. Lunkenheimer Co.

COMBUSTION CONTROL—Bailey Meter Co.

BOILER CONTROL BOARD—
- Multipointer draft gages, boiler meters, steam pressure and feedwater temperature recorders. Bailey Meter Co.
- Steam temperature controllers and recording gages for steam distribution lines. "Stabling" Foxboro Co.
- Steam flow meters on distribution lines. Republic Flow Meters Co.
- Combustion indicator. "Hazegage" Ess Instrument Co.
- Small pressure gages. "Ashcroft". Manning, Maxwell & Moore, Inc.

OIL BURNING EQUIPMENT—
- 2 Oil transfer pumps. Viking Pump Co.
- 2 Oil transfer pump motors. Westinghouse Electric & Mfg. Co.
- 2 Fuel oil pumps. Worthington Pump & Machinery Corp. 1 driven by L. J. Wing Mfg. Co. steam turbine. 1 driven by Westinghouse motor.
- 3 Twin G-Fin section steam to oil heat exchangers. Griscom-Russell Co.
- 1 Calrod immersion electric oil heater. General Electric Co.
- Thermometers on oil lines. Moeller Instrument Co.
- Governors on oil lines to burners. Fisher Governor Co.

FEEDWATER EQUIPMENT—
- 2 Steam driven boiler feed pumps consisting of De Laval Steam Turbine Co. centrifugal pump driven by an Elliott Co. Steam turbine.
- Feedwater heater. "Deaerating Type." Elliott Co.
- Feedwater Treatment. Hall System.
- Air Compressor. Fuller Co.
- Stack. M. W. Kellogg Co.



ousness is due partly to the fact that space has been provided for the future addition of air heaters.

The interior walls are faced with brick, painted light gray. The boiler walls are of light tan, pressed brick and all columns and metal parts are painted with aluminum paint. All structural steel and the breeching and a great deal of the piping is also painted aluminum. This light coloring combined with the large steel sash windows in three sides of the building gives an atmosphere of cleanliness and brightness that is startling.

The plant was designed and constructed by the H. K. Ferguson Co. under the general direction of E. J. Grimmett, Chief Engineer of General Foods Corporation, to whom we are indebted for the privilege of presenting this description.

Millers Ford

Continued from Page 42

the original cams are restored to the turbine. Hydrogen has never been removed from the generator because the latter has developed no troubles. Slight brush trouble on the main and pilot exciters have constituted the extent of the electrical problems. The availability and operation of the unit to date are 93.4 and 89.8 per cent respectively, as noted in Table I.

Boilers

Both boilers were originally equipped with an economizer of the parallel flow type but after a few months operation the manufacturers decided that a change in the economizer design was advisable to improve the feedwater regulation and drum water level problem which will be mentioned later. This change was made on one boiler in December, 1937, and on the other in January, 1938, and the economizers are now 25 per cent parallel flow and 75 per cent counterflow. No trouble has been experienced with drum levels since this change was made.

An increasing system load caused the postponement of the low pressure condenser retubing program until after the No. 7 installation was available for service. Condenser leakage caused considerable contamination of the feedwater to the high pressure boilers. Ammonia from the river water leakage, attacked all copper bearing surfaces and resulted in copper deposits on the steam generating and water wall tubes in the boilers, which, however, produced no ill effects. Feedwater contamination was undoubtedly responsible for some of the carryover in the high pressure steam during the early months of operation.

In the fall of 1937 a high pressure boiler feed pump turbine was inspected and considerable deposit was found on the blades. A similar deposit was found when the main turbine was inspected the first time, seats and discs of the valves in the steam mains were also affected but, fortunately, no deposit was found in the superheater.

At this time, however, heavy sludge and analcite scale was being deposited on the generating and water wall tubes and required frequent turbining in order to keep the boiler clean. Carryover difficulties were partly corrected by certain changes in the steam washing equipment within the drums and final elimination of both carryover and sludge problems was obtained by retubing three low pressure condensers with Muntz metal tubes; replacement of the steam driven air compressors with motor drives; improving evaporator performance; and the elimination of small sources of feedwater contamination. A later improvement consisted of the replacement of the old hot process lime and soda softener with one of larger capacity.

Scale formation diminished to the extent that on some subsequent boiler inspections it was not necessary to turbine the tubes. Recirculation was tried but resulting cross-over feedwater heater deposits and the apparent lack of economizer corrosion limited its use to a period of 2 mo.

Tube Replacements

In November, 1938, one steam generating tube failed due to internal corrosion. Various remedies were tried but failures continued on both boilers until March, 1939. During that period 15 generating tubes and 14 slag screen tubes were lost. One final change in feedwater treatment was made at the time of the last failure. In an attempt to improve circulation in these tubes at this time the restrictors between the downtake header and the mud drum were removed. Restrictors of a different

Table II. Principal data on some of the major equipment and auxiliaries in the Millers Ford top plant, Units Nos. 7 and 8

1937 UNIT No. 7

ENGINEERS. Columbia Engineering Corp., Cincinnati, Ohio.

BOILERS. Two, Babcock & Wilcox high head, sectional header type, 23 tubes wide, 1250 lb., 900 deg. F., 375,000 lb. per hr. each; heating surface 4091 sq. ft., made up of 4 in. O.D. tubes. FURNACE VOLUME, 12,100 cu. ft.; completely water cooled by 3¼ in. O.D. tubes 0.375 in. thick; 2093 sq. ft. covered by Bailey blocks; 742 sq. ft. stud tubes; 80 sq. ft. bare. SUPERHEATER, total surface 10,500 sq. ft. made up of 2½ in. O.D. tubes, 57 sections wide and arranged in two banks; upper, 19 rows, carbon steel; lower, 7 rows, chrome-moly steel. ECONOMIZER, heating surface 18,200 sq. ft. made up of 2½ in. tubes, 57 sections wide arranged in two banks; upper, counterflow 24 tubes high; lower, parallel flow 17 tubes high. AIR HEATERS, two pass horizontal, tubular with 26,370 sq. ft. of heating surface made up of 60 rows of 20 tubes, 16 ft. long, 2½ in. O.D. Each boiler has 26 soot and 4 slag blowers (Diamond); 4 drum, 2 superheater and 1 power control safety valves (Consolidated); Bailey 3 element feedwater control; Leeds & Northrup combustion and superheat control; and a Cottrell precipitator.

PULVERIZERS AND BURNERS. Six (3 per boiler) Babcock & Wilcox Type B, 7 t.p.h. pulverizers, V-belted to 125 hp. Allis-Chalmers motors. Each mill has Bailey mill-level control; a Richardson enclosed 10 t.p.h. coal scale; a 22½ in. table type feeder; a Sturtevant blower driven by an A-C 50 hp. motor; and two B & W. horizontal cross tube burners with automatic gas pilots.

COAL HANDLING SYSTEM. C. O. Bartlett & Snow Co., capacity 150 t. per hr., consisting of a 150 t. track hopper; skip hoist; apron feed conveyor; Tyler 1½ in. mesh coal screen; 30 in. wide cross and distributing conveyors; tripper; 1000 t. suspended bunker; and six 18 in. coal spouts each with gates operated by handwheel from the operating floor.

ASH HANDLING SYSTEM. United Conveyors Corp. vacuum system consisting of ashpits and dust hopper with self loading intakes, Durite pipe lines, Roots-Connersville positive displacement vacuum pump driven by a 100 hp. motor, receiver, bag filter arrestor, 100 t. ash storage tank and rotating unloaders.

FANS. Buffalo Forge Co., one forced and one induced draft fan per boiler. Forced Draft Fans each 113,000 c.f.m., 100 deg. F., 12 in. w.g. driven through 30 in. American Blower hydraulic coupling by an Allis-Chalmers 300 hp., 1175 r.p.m. motor. Induced Draft Fans each 200,000 c.f.m., 450 deg. F., 15 in. w.g., driven through 42 in. A. B. Co. hydraulic coupling by Allis-Chalmers 700/450 hp., 875/705 r.p.m. motors.

BOILER FEED SYSTEM. Evaporators and closed heaters, Foster Wheeler Co. consisting of: 2927 sq. ft., 4 pass Lockhead 780,000 lb. per hr. crossover heater with ¾ in. O.D. No. 10 B.w.g. arsenical copper tubes; double effect 20,000 lb. per hr. evaporator. Evaporator condenser, Griscom-Russell Co., 1185 sq. ft., 30,000 lb. per hr. Worthington Pump & Mach. Corp., two 750,000 lb. per hr. deaerating heaters each with a vent condenser and 125,000 gal. storage; also two, 1½ in., 20,000 lb. per hr., 303 ft. head evaporator feed pumps. Allis-Chalmers Co., three 3750 r.p.m. secondary boiler feed pumps, six stage, each 415,000 lb. per hr., 1500 lb. pressure, two driven by G.E. 1000 hp., 1200 lb. turbines, one by a G.E. 1000 hp., 230 lb. turbine.

GENERATING EQUIPMENT. General Electric Co., one 1200 lb., 900 deg. F., 230 lb. back pressure, 3600 r.p.m. turbine driving a 30,000 kw., 0.9 p.f. 12,000 v., 3 ph., 60 cycle hydrogen cooled generator and through gears a 100 kw., 250 v., 1778 r.p.m. exciter and a 2 kw., 250 v. pilot exciter.

MISCELLANEOUS. Reducing valve and desuperheater, 400,000 lb. per hr. from 1250 lb., 900 deg. F. to 230 lb. 550 deg. F., Republic Flow Meters Co. Auxiliary power transformers, two 3750 kv-a., 12,000/440 v., Allis-Chalmers Mfg. Co., Auxiliary switchboard, 440 v., I-T-E Circuit Breaker Co. Piping, Pittsburgh Piping & Equip. Co. Large valves, Wm. Powell Co. Small and blowoff valves, Edward Valve & Mfg. Co. Recording pressure gages and indicating thermometers, Foxboro Co. Draft gages and CO_2 recorders, Republic Flow Meters Co. Flow Meters, Bailey Meter Co., Indicating pressure gages, Consolidated Ashcroft Hancock Co. Elevator, Otis Elevator Co.

UNIT No. 8 (UNDER CONSTR.)

Practically a duplicate of No. 7 with the minor exceptions noted in the text and drawings. On the generator the hydrogen-control and shaft-sealing systems have been simplified and compacted.

design were placed between the slag screen and lower row of generating tubes in the uptake header.

No failures occurred during the next twelve months. Then in March, 1940, a generating tube failed, causing an immediate boiler shutdown. A careful inspection indicated that slight, active corrosion was present but by no means as bad as found earlier. The other boiler was taken off for inspection and no active corrosion could be observed. However, it was decided to replace all tubes showing any appreciable corrosion in both boilers. Five were replaced in one boiler and 16 in the other. These were all generating tubes, and brought the total replacements to date to 36 generating tubes and 14 slag screen tubes.

Several tests made with a U. S. Bureau of Mines Embrittlement Tester indicate that caustic embrittlement is not a problem on these boilers. Disodium phosphate is the only chemical added to the feedwater. Feedwater at the present time has a pH value of 6.9 and a solids concentration of 1.0 p.p.m. A blowdown of 0.1 per cent maintains a boiler water concentration of about 150 p.p.m. of solids. The steam contains about 0.5 p.p.m. of solids. A typical analysis of boiler water at present in p.p.m. is: SiO_2, 10; R_2O_3, 2; NaOH, 31; Na_2HPO_4, 30; Na_2SO_4, 35; NaCl, 9; Na_2CO_3, 3; organic, 16; total solids, 136. The pH value is 10.6.

Each boiler had one complete overhauling of its furnace after approximately 2 yr. of operation. The cast iron blocks forming the corners between the rear wall and each of the side walls had been burned away. The same was true of the blocks between the rear apron and each of the side walls. These blocks were removed, small triangular pieces welded to each corner tube and the space between the pieces was filled with chrome ore.

Some blocks around the retractable slag blowers on the rear and side walls had to be replaced as did some on the upper portion of the rear apron. It is possible that all of these failures were caused by the breaking of the heat conducting bond between the blocks and the tubes. Edges of the blocks parallel to the tube had a tendency to curl and this was corrected by beveling these edges on all new blocks. Lower portions of the downtake and uptake sectional headers showed evidence of excessive heat. Chrome ore applied to the headers, supported by Allegheny metal plates and refractory material, proved to be the solution to this problem.

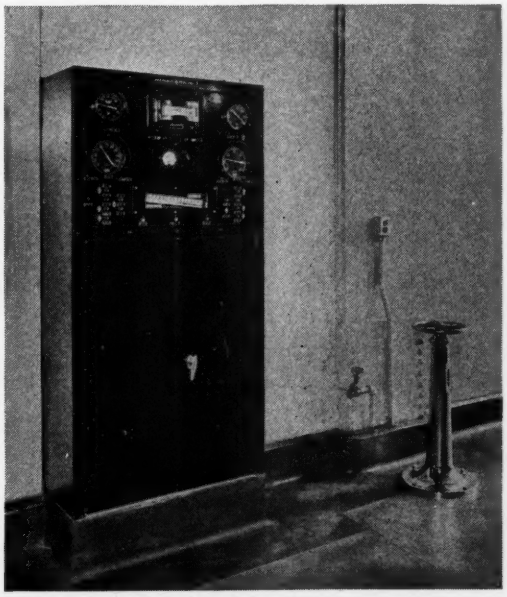


Fig. 8. Hydrogen control panel for No. 7 Unit

Deslagging

Four retractable slag blowers, two in the rear wall and one in each side wall, are in use and have proved to be satisfactory. The need for additional blowers of this type has become evident and they will be installed, both in the original and new high pressure boilers. The two additional units on each boiler will be in the upper part of the rear wall. On one occasion during the initial operating period the economizer and superheater tubes of one boiler were so badly bridged over that considerable hand cleaning was required but slag does not constitute a problem if coals with an ash fusion temperature of 2850 deg. F. or greater are burned and if the slag blowers are kept in good operating condition. It has been observed that a mixture of brands of coal, both having the same ash fusion temperature, tends to produce more slag than either coal will when burned alone.

New Boilers

One of the principal differences between the present No. 7 boilers and the new ones for No. 8 unit is in the furnace walls. The latter will have largely bare tube water walls and the remaining area bare tubes partially studded, with carborundum between the tubes. The exception to this is in the ignition area on the side walls opposite the burners where the tubes will be fully studded and chrome ore will be used as on the present boilers. Economizer tube and cap leaks necessitated the seal welding of all economizer tubes at the various headers, and the replacement of the stainless steel cap gaskets with mild steel flexible gaskets. This practically cured the leak problem.

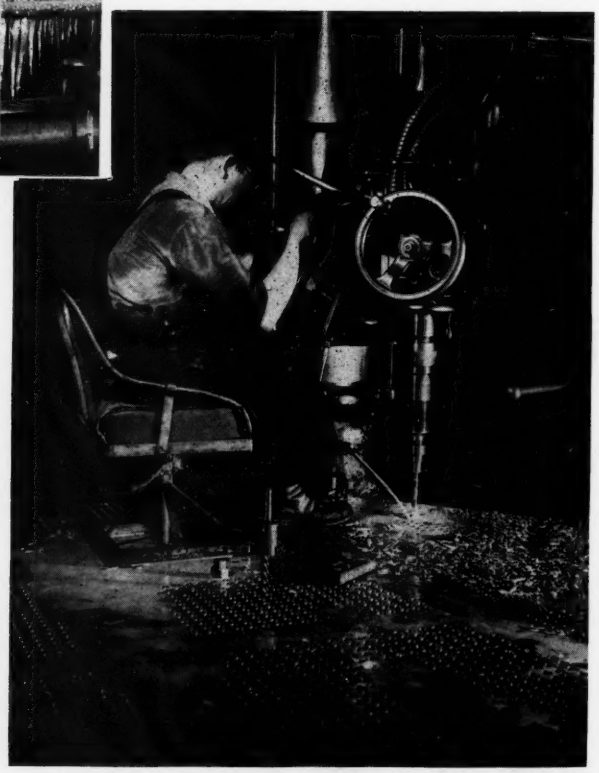
Economizer construction is such that the economizer tubes pass through the boiler setting in three different locations. The superheater tubes only pass through the setting twice. At these points most of the air infiltration occurs, although this is not sufficient to affect boiler performance. The CO_2 drop from the furnace to the boiler exit is about 1.5 per cent and the boiler efficiencies average about 88 per cent.

During 1939 one boiler was on the line 4 mo. and the other one for almost 6 mo. of continuous operation. Their outputs averaged approximately 270,000 lb. per hr. each during those periods. When they were taken down for inspection and cleaning, no major work was required.

(To be concluded)

PICTURES

This looks like a picture taken after a fire in winter but there really was no fire. It merely shows conditions prevailing during an ice test of a new Delta-Star high pressure contact switch. These switches are designed to operate under heavy ice conditions which often prevail in northern regions but just to check up, a three pole switch was thoroughly coated over with an inch of solid ice to see if the blades would open; they did, all three of them. Similar freezing tests were also made with blades in open position, and they easily closed. This picture showing a close-up of one of the poles gives some idea of the severity of the test. Since switches of this type are usually located outside, exposed to all sorts of weather tests such as these are necessary. This particular switch is rated 161 kv. 1200 amp.

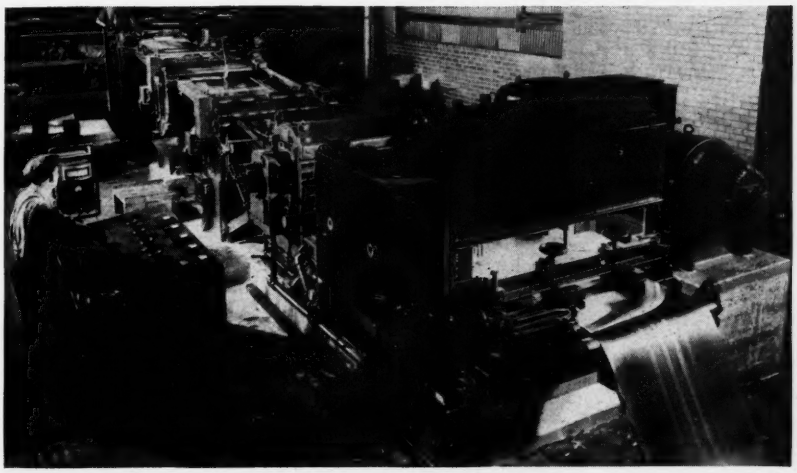


Drilling a large condenser tube sheet is a tricky and laborious process. The photograph at the right shows how it is done at the plant of the Allis-Chalmers Mfg. Co. in Milwaukee, Wis.

At the left is shown the world's first practical woman's hat. What in normal times might pass for a spring millinery tip from Paris, now might go as a spring military tip to Paris. The cute little number the lady at the left is wearing is not a new bonnet, it's just a General Electric reflector designed to shade—of all things, so un-chic—alley lights! The reflector is of aluminum in radial wave form with an Alzak finish. The bend is to keep light out of bed room windows. The young lady is Virginia Peck of Schenectady, N. Y.

# of Engineering Interest

Here is a picture of the world's longest conveyor, the 9 mile "roller coaster" to convey sand and gravel to the concrete mixing plant at Shasta damsite, on the Sacramento River in California. Shasta dam will be the second largest dam in the world, smaller only than Grand Coulee, and will form the key structure of the great Central Valley Federal Reclamation Project. The structure will be 560 ft. tall and 3500 ft. long. It will have an overflow spillway in the center and a power plant with a capacity of 350,000 kw. will be built at its base



In the machine at the left, the eternal vigilance of the photo-electric cell is used to spot holes as small as a hundredth of an inch in a sheet of steel moving up to 1000 ft. per min. Built by Westinghouse this hole detector simplifies quality production in this steel mill shearing line. Two light sources are mounted below the moving stream of metal sheet on a separate foundation to avoid vibration. The slightest hole in the steel strip lets the light through, actuating the phototube and a marking device that scores the strip alongside the hole.

Grand Coulee power house gets a roof over its head. Activity at the dam now centers about this west wing which will house generators almost a third larger than the biggest now in operation at Boulder Dam. This west power house is itself the biggest building in the Pacific Northwest—765 ft. long and 85 ft. wide. Its twin on the east bank will be built later when the power it will provide is needed. As shown in the picture the building on which activity has focused all winter is nearing completion

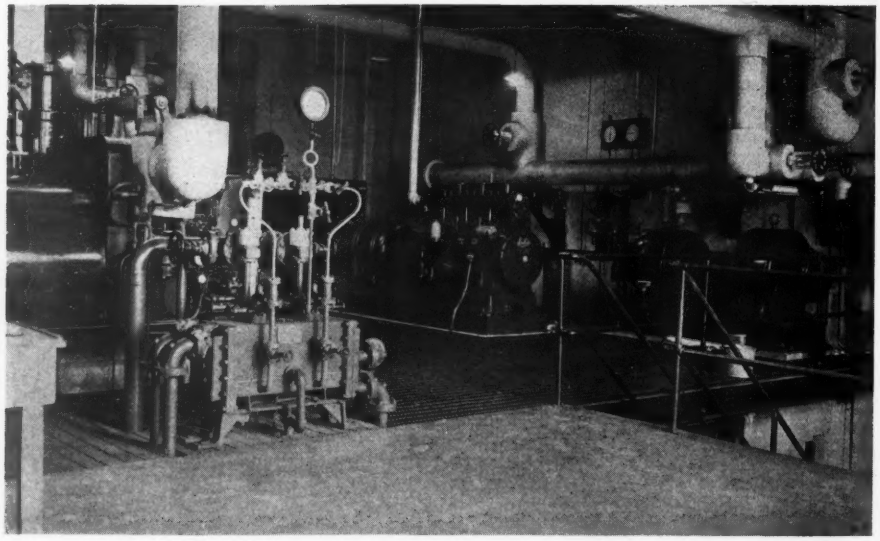


Fig. 1. A general view in the turbine room of the National Vulcanized Fibre Co. plant

"High Pressure" Reduces Power Costs in Industrial Plant

THE TREND toward the use of high steam pressures and temperatures in central stations and in the larger industrial power plants naturally raises the question as to whether high pressures and temperatures offer similar advantages in smaller plants, particularly those small plants using low pressure or exhaust steam for processes in the factory. As in all engineering considerations, the correct answer to this question lies in an exact analysis and evaluation of all the conditions existing in the particular case under consideration. There can be no general answer. Each case, almost, is different and yet the advantages inherent in the use of high steam pressures are such that if all conditions are analyzed accurately and the results properly interpreted there are probably few plants where a change from low to high pressure operation will not be justified. In any particular case, it is intriguing to indulge in gymnastics with B.t.u.'s and heat balances but in the final analysis the one thing that is of importance is, how much money will such a proposed change save and if new equipment must be purchased, how soon can the savings effected pay for such new equipment?

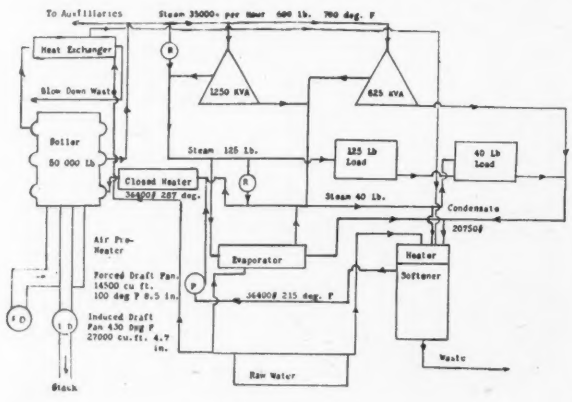


Fig. 2. Heat balance diagram

Such a situation existed several years ago at the plant of the National Vulcanized Fibre Co. at Yorklyn, Del., and since the work done at this plant has a direct bearing on this general question of Low vs. High Pressure Steam, a brief consideration of it here will be to our advantage.

Originally, a 125 lb. pressure system at this plant furnished steam for large Corliss engines which were belted to the main drive shafts in the mill for group driving. This engine drive had been abandoned, however, and in recent years power had been purchased from the local utility. Steam was generated for use in the auxiliaries, the drying cylinders of the paper and fibre machines and the evaporators used for condensing spent liquors.

To determine whether the installation of a high steam pressure electric generating plant would be justified, studies were made under the direction of F. H. Cronin, the chief mechanical engineer of the

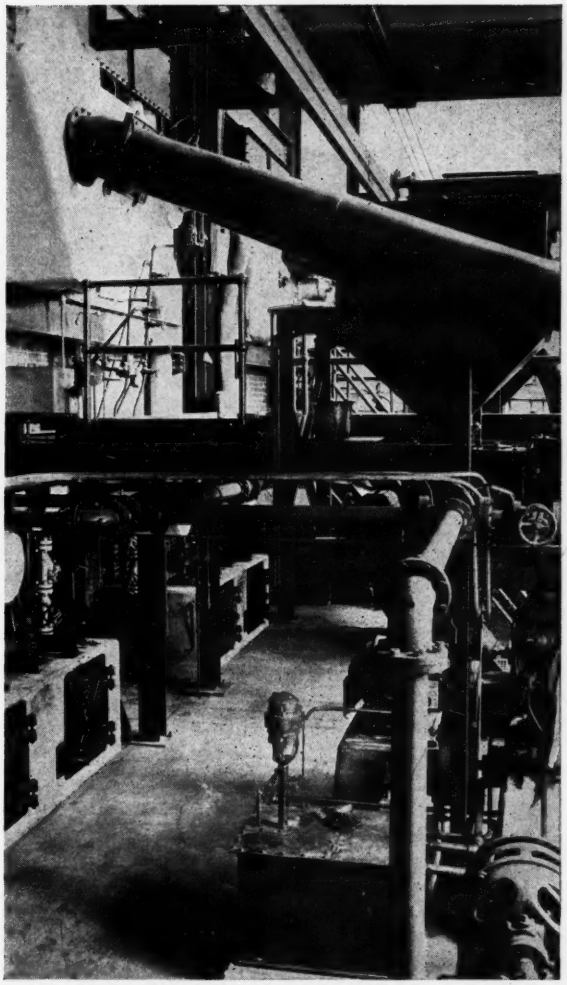


Fig. 3. A view in the boiler room showing the pulverized coal equipment

company, the consequence of which was a program of rehabilitation involving the installation of two high pressure boilers and two turbo-generators, together with necessary auxiliaries. Now no power is purchased and in addition to supplying the mill's own steam and electrical requirements, steam and edectric power are sold to another nearby industrial plant—that of Marshall Bros. The net result of this change was a reduction in the power costs such that the total power costs today are only slightly more than the cost of the fuel for the old plant alone, due to greater operating cost of the new plant requiring a larger and better trained personnel.

In the studies which led to the installation of the new plant, it was necessary first to work out a heat balance such that the load could be evenly distributed over the 24 hr. period. This heat balance, shown in Fig. 2, indicated an hourly base load of 35,000 lb. A minimum of 13,000 lb. per hr. was used as a 100 per cent boiler rating basis and a boiler with a rating of 13,000 lb. per hr. at 100 per cent, and able to produce 30,000, 45,000 with an ultimate rating of 55,000 lb. per hr., was considered. Pressure studies led to the selection of 600 lb. at 700 deg. F.

Two boilers were installed. One can carry the load but two units were decided upon so that a spare would be available in case of an accident to one. Both boilers are identical, being Edge Moor Iron Co. units rated at 418 hp. with 4000 sq. ft. of heating surface and designed for operation at 600 lb. pressure.

These units are arranged for pulverized coal firing but because of a decided price advantage in favor of oil, they are now being fired by oil.

These boilers deliver 600 lb. steam to two Westinghouse turbine-generating units, one a 1250 kv-a. back pressure unit and the other a 625 kv-a. condensing machine arranged for steam extraction at 40 lb.

These generating units can handle the entire steam and electrical load under varying conditions but to make the plant a self contained unit a standby source of power was thought desirable and a gasoline driven generator was installed. The cost of a standby connection with the utility company was such that such a gasoline driven unit could be paid for in about three years' time. This standby unit consists of a 6 cylinder Buffalo Gasoline Motor Co. engine, direct connected to two generators, one a 100 kw., 480 v. General Electric a. c. generator and the other a 50 kw., 110 v. d.c. generator for battery charging. In case of flood or other emergency the gasoline engine can generate enough current to start the fuel oil pumps and auxiliaries. The two generators are so arranged that they can be operated as a motor generator set separate from the engine to supply th small amount of direct current needed throughout the mill.

When the new equipment was first placed in operation it was found that because of fluctuations in the steam load, the smaller of the two turbines would often be carrying considerable overload, the result of lack of enough equipment to take up the exhaust steam from the large turbine.

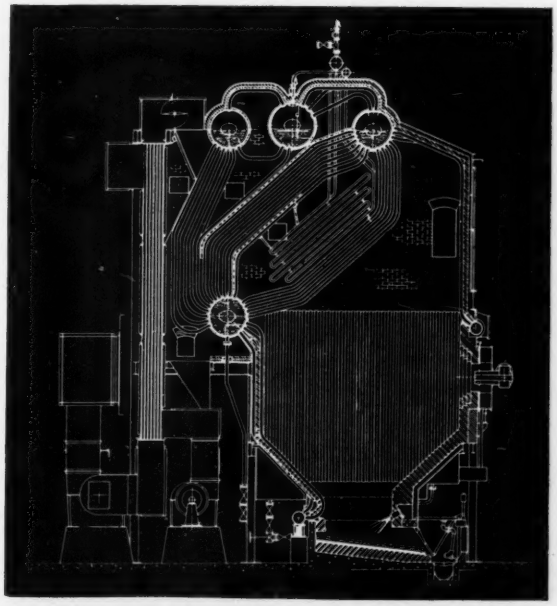


Fig. 4. Cross section of the four drum bent tube boiler

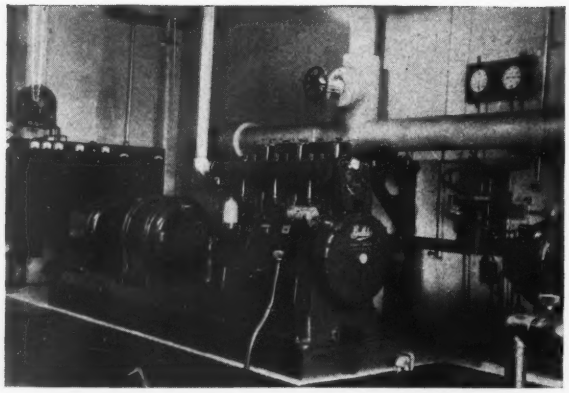


Fig. 5. The gasoline driven emergency generator unit

To smooth out this load condition it was decided to install an evaporator. This evaporator serves two purposes: it generates steam and supplies additional condensate to reduce the makeup; it generates steam almost pound for pound at atmospheric pressure which when condensed takes the place of just so much raw water. In order to condense this steam, an evaporator condenser was also installed. This unit requires 66,400 lb. of raw water per hr., increasing the temperature of the water from 60 to 180 deg. The heat so derived is not lost since the raw water is used for process work in the mill and reduces the steam load for treating plant water.

The arrangement of the equipment in the plant is shown in the accompanyng photograph and the piping arrangement is indicated in the heat balance diagram. As will be noted, a continuous blow down system is provided. This consists of a 1-in. pipe connected to the forward top of No. 1 boiler drum and connected to a heat exchanger of the closed type which transfers the heat in the blow down to the water going to the softener.

No economizers were installed but 4050 sq. ft. tubular air heaters are provided for preheating the furnace air. The furnaces are water cooled with bare water walls except on the burner side. The arrangement of the boiler furnace and air preheater is shown in the cross section in Fig. 4.

The raw water mark-up of the boiler plant varies. In the summer season it is about 65 per cent with 35 per cent returns but in the winter season about 65 per cent is made up and the returns 45 per cent. The reason for this is that one of the main steam loads is the evaporators used in the mill processes. While the condensate from these evaporators might be recovered, the danger from acid contamination does not make it desirable so it is wasted. The returns are delivered into a separate compartment in the deaerating heater where the temperature is raised from about 180 to over 215 deg. F. This water flows in a separate line and meets the softened water beyond the filter. The raw water is fed into another compartment of the deaerating heater and is then mixed with various chemicals, softened, allowed to settle and the softened water then fed through a magnetic filter to the pump where it meets the condensate returns.

Although the pulverized coal burning equipment was installed at the same time as the new boilers and turbines, it has never been used. The price of fuel oil has always been very favorable. The original arrangement provided for only one oil burning nozzle alongside the pulverized coal burners but this has given way to two; one on each side, an arrangement which gives the operators better control of the steam and no head is lost when it becomes necessary to change burners with increase or decrease in load. The oil burning system uses mechanical atomization, the oil pressure and the air to the furnace being controlled by Brooke Automatic Control.

As already mentioned, both steam and electric power are sold to the nearby plant of Marshall Bros. Steam for Marshall Bros. is usually obtained from an extraction point on the back pressure turbine. An effort is made to run on the back pressure turbine at all times except when the load is so light that it becomes more economical to run the condensing unit. The extraction point on this turbine is just beyond the first stage. At first an attempt was made to control this extraction pressure by hand but this was not found feasible so an automatic extraction arrangement was suggested. This was given some consideration but finally a Swartwout reducing valve controlled by a Swartwout regulator was placed in the extraction line to keep the pressure beyond the reducing valve at 110 lb. for the Marshall plant. With this arrangement the pressure at the extraction point varies widely with the load —from 225 lb. down to 110, but the reducing valve keeps the pressure at the Marshall plant constant. The line to the Marshall plant is about 1700 ft. long and though the steam at the extraction stage is highly superheated, it reaches its destination in practically a saturated condition.

Another interesting feature about this plant is the high voltage system of electric transmission to the Marshall Bros. plant. Current is generated at 460 volts which is usual industrial plant practice. For the Marshall Bros. plant, however, this voltage is

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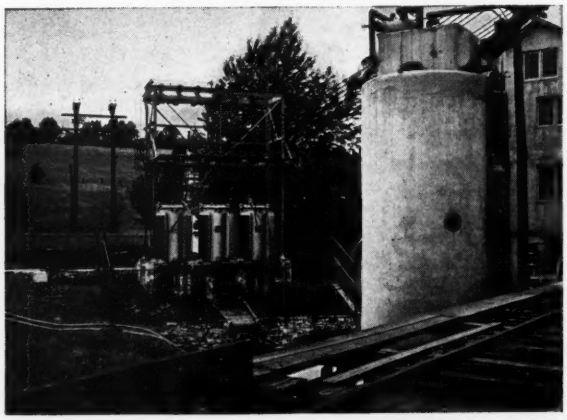
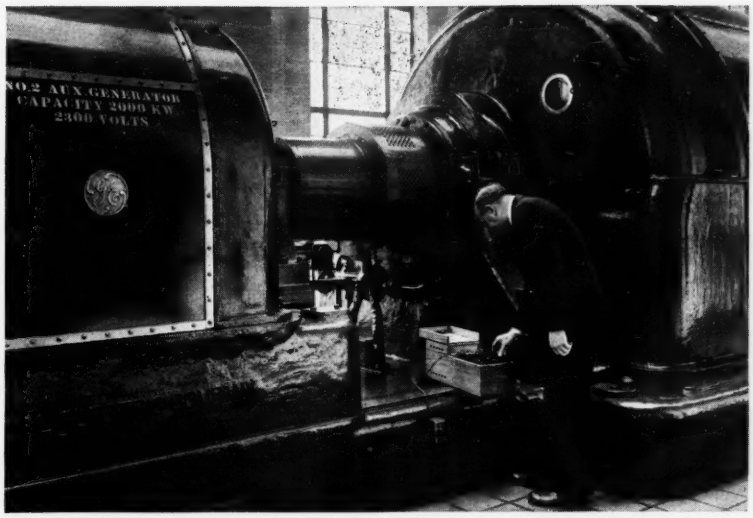


Fig. 6. An outdoor view showing the high voltage substation for stepping voltage up to 13,000 v. for transmission of power to the Marshall plant



Measuring the insulation resistance of a generator with the megohm bridge

INSULATION RESISTANCE TESTS

SINCE THE INSULATION RESISTANCE of electrical machinery varies with age, voltage, moisture content, and other physical factors, its measurement affords a possible index of the condition of the insulation. After generators have been inundated by floods as has happened in many localities in recent years, or after repairs have been made, measurements of the insulation resistance are used to determine when the insulation has dried out sufficiently to permit machines to be put back into service. In the case of old machines, periodic measurements are used as a check against possible failure in operation. Such measurements are equally useful as a check on the quality and condition of transformers and cables.

There are several methods of making insulation resistance measurements, some of which are well known and have been used for many years. One of these methods involves the use of the Wheatstone Bridge in which three known resistances and the unknown resistance to be measured are connected in the form of a diamond and with a galvanometer across the center.

The important requirements of a test instrument are that it be accurate and simple to operate. For resistance measurements both of these requirements are met by the Wheatstone bridge but the use of the bridge for resistance measurement has been hampered in the past by lack of sensitivity which to some extent has restricted its use.

With the availability of modern electron tubes, however, this limitation has been removed and it is possible to obtain the required sensitivity in a portable, completely self-contained instrument. The new Megohm Bridge recently developed by the General Radio Co. is an instrument of this character.

Before discussing the design and use of this bridge it will be well to consider the dielectric absorption effects in the measurement of insulation resistance. Because insulation resistance changes rapidly with both voltage and the time of its application, it is important that a standard test voltage and a standard time interval be used. For the standard voltage, 500 v. has been widely used.

In spite of the fact that the apparent insulation resistance of an electric machine or cable increases after the application of voltage, it has been standard practice, until recently, to take the value of resistance at the end of one minute and to disregard the further increase. While this method is reasonably satisfactory for the poorer types of insulation, it fails entirely for the better grades, particularly those that are laminated, like the pasted mica used in high voltage generators. The time needed to attain equilibrium is measured in hours and even days.

It should be obvious that under these conditions the apparent resistance for one minute electrification bears no relation to true insulation resistance but merely measures the current due to volume charge at that instant. The value of the true insulation resistance at increasing time intervals and plotting the observed data. The slope of the resistance time plot at some convenient time interval

Fig. 1. Panel of the megohm bridge

is also of considerable significance. The accompanying plots show how the apparent insulation resistance of various electrical machines and cables varies with the time of application of the test voltage. For measurements over periods as long as these simple and convenient measuring equipment is a necessity.

The bridge described here meets these requirements. It consists of a conventional Wheatstone Bridge but with a sensitive vacuum tube voltmeter instead of the usual galvanometer used as the null indicator. The panel of the bridge is shown in Fig. 1, the circuit in Fig. 2.

For those not familiar with the vacuum tube voltmeter, a few words of explanation are desirable. The vacuum tube voltmeter makes possible the measurement of voltages in circuits where any other form of instrument would so disturb the conditions that they would no longer be normal. The ordinary direct current voltmeter of the D'Arsonval moving-coil type, is in reality a current-operated device since it depends upon a current flow to create the change in the magnetic field on which the movement of the pointer depends. This type of meter, therefore, always consumes power from the circuit being measured, the power being equal to the product of the voltage across its terminals times the current through it.

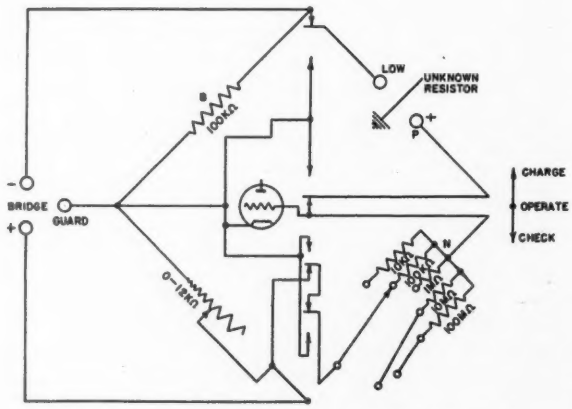


Fig. 2. Schematic circuit of the megohm bridge

In sensitive meters the current is small and in low resistance circuits can be supplied readily without causing any appreciable error in the measured voltage but in high impedance the current flow causes an appreciable increase in voltage drop in the circuit and a consequent error in the measurement. To avoid this difficulty, a voltmeter is required which consumes no current, and the vacuum-tube voltmeter serves this purpose since the grid circuit, when properly biased, consumes no grid current.

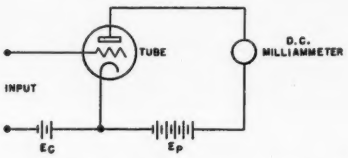


Fig. 3. Diagram showing the principle of the electron tube voltmeter

A simple diagram of a vacuum tube voltmeter is shown in Fig. 3. The voltage appearing across the grid and the cathode is transformed by the tube into a corresponding current in the plate circuit which may be measured by a milliammeter calibrated to read volts. The current for operating the milliammeter of course is supplied from the local battery. This diagram is presented merely to illustrate the principle of the vacuum tube voltmeter, it must not be considered a practicable circuit since, as shown, it has marked limitations. Nevertheless very small potential applied across the input terminals of such an arrangement will result in a deflection of the milliammeter which will be proportional to the applied voltage.

It is this principle of measurement that is used in the General Radio Megohm Bridge. In this instrument the sensitivity of the Wheatstone Bridge is so greatly increased through the use of the vacuum tube detector that resistance of the order of 10^{12} ohms can be detected. Resistance values are read directly from a dial and multiplier switch so that measurements can be made quickly and conveniently. The scale is approximately logarithmic, giving a constant fractional accuracy of reading over one decade for each multiplier setting.

The effective scale length is 35 inches between 0.1 megohm and 10,000 megohms. There is a further scale length of 2½ inches between 10,000 and 100,000 megohms, while another ½ inch brings the scale to 1,000,000 megohms.

The instrument is equally well adapted to one minute readings and longer time measurements. A 3 position switch is provided with the positions "check," "operate" and "charge" indicated on it. The check position is used for checking the galvanometer zero. The operate position is used for making measurements. In the charge position, the normal operating voltage is applied directly to the

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Short Center Drive Performance

By LLOYD H. SKOUGER
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Competitive performance of the short center pivoted base drive determined by a series of tests carried out at Worcester Polytechnic Institute. Consistent performance of this drive over a wide range of load due to accurate and automatic control of predetermined belt tension.

DESPITE the tremendous effort expended in the past years of conserving power and increasing machine output, these efforts can and have, in many cases, been canceled because of antique and inefficient mechanical power transmission equipment.

Mechanical means of power transmission is unfortunately a subject of considerable misconception, and too often equipment is misapplied because of its eye appeal or merchandising methods that have attracted the interest of the user. Of the existing type of drives, whether they be V-belt, direct, chain or flat leather belt drives, all have their proper application. With the difference of opinion as to the merits of each of these groups, and with no counsel other than that of those competitively involved, many misapplications exist today in all types through the absence of readily available factual data.

With the modern industrial demand of compactness resulting in individually driven machines and short center drives, the leather belt formerly fell short in this field, and was for a time considered outmoded. In spite of the fact that idler drives were common, this type at best was detrimental to good over-all performance.

In the absence of a common standard for good belting practice, much misapplication took place due primarily to underbelting, and caused in many cases through recommendations by those who were competitively involved. Many drives have been condemned because of underbelting, where a properly sized belt and pulley would have been entirely satisfactory.

Development of the short center pivoted base drive, with its automatically maintained tension, has completely answered the demand of modern equipment and plant layout. This is the case not only from a theoretical viewpoint, but has proven itself in the field, particularly in industries where constant high driven speeds must be maintained with minimum slip and power cost, and where "trouble-free", continuous service was needed.

The Short Center Pivoted Motor Base Leather Belt Drive Book of the American Leather Belting Association has so simplified the design of the short center drive that even those unfamiliar with belting practice can apply these drives with the use of this book, without complicated calculations.

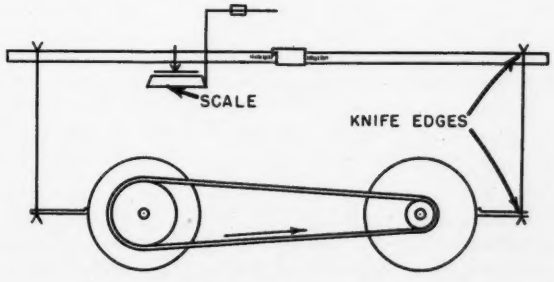

Fig. 1. General principle of the test set-up

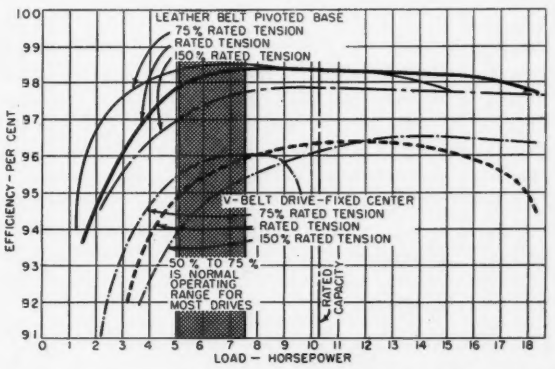

Fig. 2. Test results with a 2.16 to 1 pulley ratio, 1725 r.p.m. motor pulley speed and 3161 f.p.m. belt speed

Results of extensive test work and research, made by Prof. M. M. Price of Worcester Polytechnic Institute in Massachusetts, represent results of a higher accuracy than tests made heretofore. The equipment used is somewhat unique compared to earlier equipment used and the general principle of the test set-up is shown in Fig. 1.

All rotating parts were on ball bearings, all movable parts on knife edges, tensions were closely controlled and an Alden absorption dynamometer was used. With this set-up torque differences were measured directly with an overhead beam, eliminating the number of readings and chances of error necessary when measuring input vs. output. The main purpose of these tests were to gather comparative data between a center V-belt multiple drive and a pivoted base leather belt drive.

The consistency that was maintained in showing these advantages gave further proof of the accuracy with which they were conducted. The accompanying charts, Fig. 2 and 3, show graphically

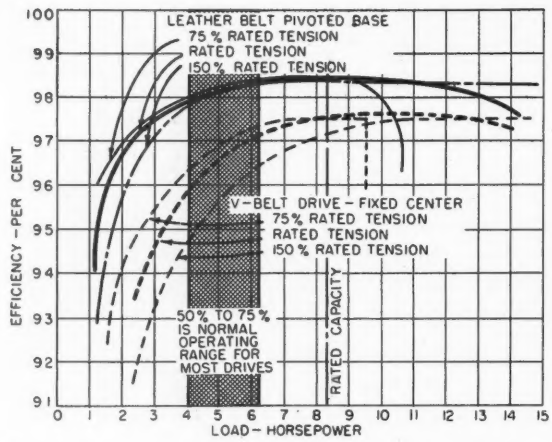

Fig. 3. Performance with a 5.43 to 1 pulley ratio, 1140 r.p.m. motor pulley speed and 2080 f.p.m. belt speed

these test results with varying pulley ratios selected as representative of average field installations.

The maximum deviation of individual reading is about 0.2 per cent from the curves plotted and it is probable that the curves are accurate to within about 0.1 per cent. The flat belt pivoted-motor drives operate at close to maximum efficiency from 50 to 150 per cent of rated capacity at rated tension. This is important because most drives operate at much less than rated capacity most of the time, rated capacity being attained only during periods of starting or peak loads. The shaded area on the charts shows the normal operating range of most drives. The tension in flat leather belt-pivoted motor base drives can be predetermined and is automatically maintained.

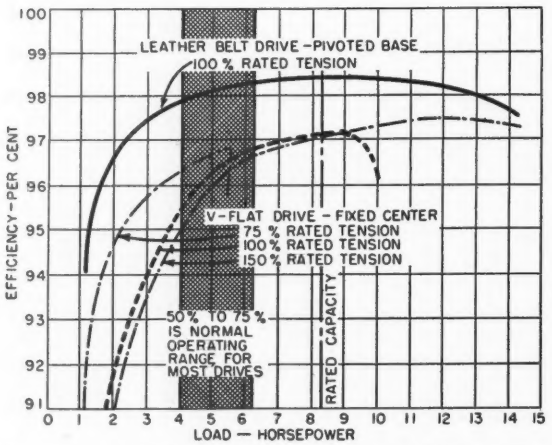
LEATHER BELT DRIVE - PIVOTED BASE
100 % RATED TENSION
V-FLAT DRIVE - FIXED CENTER
75 % RATED TENSION
100 % RATED TENSION
150 % RATED TENSION
50% TO 75% IS NORMAL OPERATING RANGE FOR MOST DRIVES
RATED CAPACITY
EFFICIENCY - PER CENT
LOAD — HORSEPOWER

Fig. 4. Test conditions the same as in Fig. 3 but with the 38 in. V-belt grooved sheave replaced by a 38 in. flat pulley

Tests shown in Fig. 4 were run under conditions identical with Fig. 3 except that the 38-in. grooved sheave was replaced by a 38-in. flat pulley. This practice is sometimes followed in order to avoid the expense of a large sheave or the expense of machining grooves in an existing flywheel. Note that the capacity of the V-flat drive is decidedly less than that of the standard of the V-belt drive in Fig. 3 and only when extremely high tensions are used does this drive have overload capacity. When the tension falls below rated tension the drive will only carry about 65 per cent of its rated capacity before excessive slip takes place, another illustration of how extremely sensitive the V-belt drive is to tension.

Insulation Resistance Tests

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unknown resistance. This allows the charging voltage to be applied for any desired length of time before the measurement. Alternately, of course, the operate position can be used and the bridge balance maintained by adjustment of the "megohms" dial. When this is done, readings taken at frequent

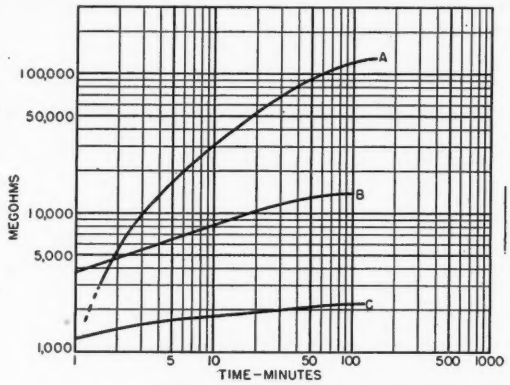


Fig. 4. Plots of insulation resistance for a transformer and two cables. A is a 1500 ft. 600 v. rubber insulated cable. B is a 5 kw. 6900 v. transformer. C is a 7 kv. rubber insulated cable 1040 ft. long

intervals will yield data for a resistance vs. time curve, such as those in Fig. 4 and 5. The measurement is not affected by ordinary electrostatic or electromagnetic fields encountered in the generating station.

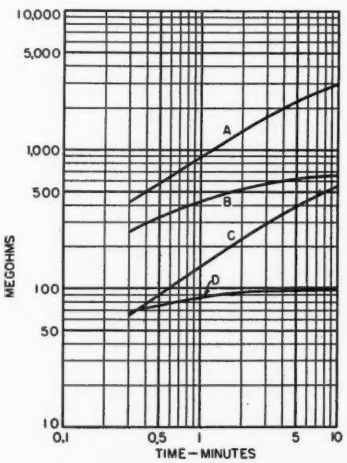
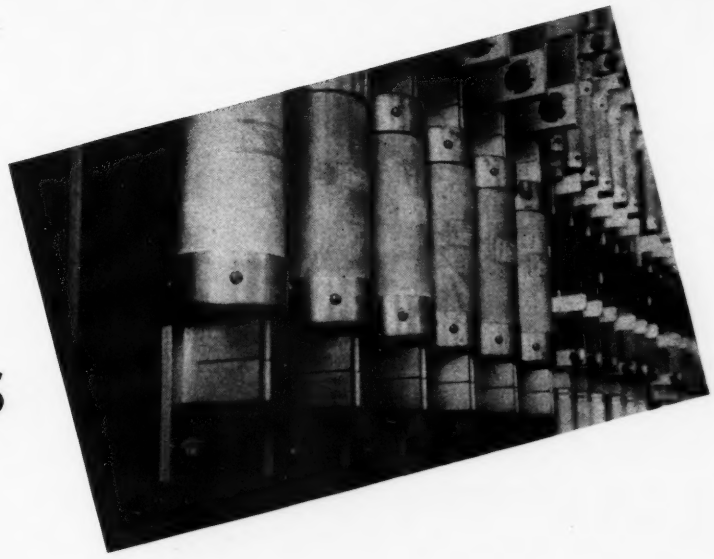


Fig. 5. Plots of the insulation resistance for four generators having the same type of insulation but differing in voltage, age, and physical condition

The bridge has a built-in power supply not shown on the circuit in Fig. 2 and operates directly from a 115 v. a.c. system. The voltage applied to the insulation under test is 500 v. in accord with the standard test conditions, though a test voltage of 100 v. is also provided for testing insulation of very low dielectric strength.



Calculations on the Three-Wire System

By EUGENE GEORGE KEY

WHEN EDISON designed his three-wire system, he made possible the saving of many dollars in copper in wiring installations, but complicated direct current and single phase current calculations. Because of the many difficulties contractors, wiremen, and even students have with this system, a few simple expressions have been devised to allow rapid and accurate calculations by anyone with a knowledge of arithmetic.

In Fig. 1 the Edison three-wire system is shown in its simplest form. G_1 and G_2 are the voltages across each half of the supply and G_T is the total supply voltage across the system. R_1, R_2, and R_3 are the resistances of the lines connecting supply and load, while I_1, I_2, and I_3 are the currents in these lines. L_1 and L_2 are the voltages across the respective loads and L_T is the total voltage across the system at the load. Arrows are placed near the lines AB, CD, and EF to show the direction of current flow. The arrows for I_1 and I_3 are always in the direction shown, but I_2 may, under some conditions, flow in the opposite direction, since line CD takes only the difference between the currents in the other two lines. In a perfectly balanced system, I_2 will be zero. In this discussion, however, the direction of I_2 will be assumed to flow according to the arrow of Fig. 1 unless otherwise specified.

In the circuit of Fig. 1, the voltage ABDFE is equal to the voltage ACE, since it is measured between the same two points. We may then write:

$$L_T = G_T - (E_1 + E_3) \qquad (1)$$

where $E_1 = I_1 R_1$ and $E_3 = I_3 R_3$, or the voltage drop in the outside lines AB and EF respectively. The voltages across each load (L_1 and L_2) are then:

$$L_1 = G_1 - (E_1 \pm E_2) \qquad (2)$$

$$L_2 = G_2 - (E_3 \pm E_2) \qquad (3)$$

where $E_2 = I_2 R_2$. The $\pm$ sign means that E_2 should be added or subtracted depending on the direction of the current I_2. In Fig. 1, I_2 is shown flowing in the same direction as I_3 so that its voltage drop E_2 must be subtracted from E_3 in (3) and added to E_1 in (2). If I_2 flowed from C to D, E_2 would be subtracted from E_1 in (2) and added to E_3 in (3). In other words, E_2 must be added to the voltage drop in the line whose current is flowing in the direction opposite to I_2 and subtracted from the volt-

DO not let the equations which are scattered throughout this article dissuade you from reading it, provided you have some interest in three-wire systems. They are not as difficult as a first glance might lead you to infer; for the greater part they involve only simple arithmetic and where algebra is used it is only of the simplest character. As the author points out, though the Edison three-wire system is simple enough to understand, it is more difficult to calculate the current in the respective branches than it is in the case of two-wire systems. By means of the simple equations derived by Mr. Key, however, the calculations of these currents can be made quite easy, not beyond the ability of any practical engineer. While the three-wire system was originally devised for direct current distribution, the principles apply equally well to three-wire single-phase alternating current systems.

age drop in the line whose current is flowing in the same direction as I_2.

As an illustration, suppose that R_1, R_2, and R_3 were equal and have a value of 0.05 ohm each. I_1 is 10 amp., I_2 is 5 amp. in the direction shown in Fig. 1, and I_3 is 15 amp. Since I_2 is in the same direction as I_3 and opposite to I_1, its voltage drop will be added to E_1 and subtracted from E_3. If each supply voltage G_1 and G_2 is 100 v., then the load voltage will be:

$$L_T = 200 - (0.5 + 0.75) = 198.75 \text{ v.}$$
$$L_1 = 100 - (0.5 + 0.25) = 99.25 \text{ v.}$$
$$L_2 = 100 - (0.75 - 0.25) = 99.5 \text{ v.}$$

and to check, $L_1 + L_2 = 99.25 + 99.5 = 198.75$, or L_T.

If an Edison three-wire system is very much unbalanced, the voltage L_1 or L_2 may be even higher than G_1 or G_2 and the other load voltage be correspondingly lower. Suppose $I_1 = 10$ amp. $I_2 = 30$ amp. in the direction C to D (opposite to that shown in Fig. 1), and $I_3 = 40$ amp., all other given values being the same. As I_2 now flows in the same direction as I_1, the load voltages are:

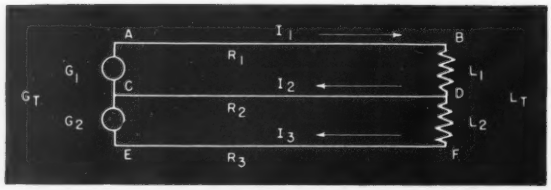


Fig. 1. The Edison three-wire system in its simplified form

$$L_T = 200 - (0.5 + 2) = 197.5 \text{ v.}$$
$$L_1 = 100 - (0.5 - 1.5) = 101.0 \text{ v.}$$
$$L_2 = 100 - (2 + 1.5) = 96.5 \text{ v.}$$

and as a check, $L_1 + L_2 = 101.0 + 96.5 = 197.5$ v. This example shows one reason why three-wire systems must be kept as nearly balanced as possible.

Suppose the three currents are not known, but the effective resistance of all loads, whether in parallel or series, is known, as well as the supply voltages. This problem, solved by the usual methods, becomes quite complicated. The only way that it can be solved is by setting up three equations by means of Algebra and the laws of the electric circuit. A direction must be assumed for I_2 although the results will be just as accurate regardless of the direction that I_2 is assumed to flow. The three equations from Fig. 1 are:

$$I_1R_1 + I_1L_1 + I_2R_2 = G_1 \qquad \text{(a)}$$
$$I_3L_2 + I_3R_3 - I_2R_2 = G_2 \qquad \text{(b)}$$
$$I_3 = I_1 - I_2 \qquad \text{(c)}$$

In an actual case, of course, values would be substituted for R_1, L_1, R_2, R_3, L_2, G_1, and G_2, but the purpose here is to obtain an expression that will eliminate the work of solving other similar equations every time the currents in a three-wire system are to be determined. An algebra student may solve the three equations and obtain values for the three currents as follows:

$$I_1 = \frac{R_2G_2 + G_1(L_2 + R_3 + R_2)}{(R_1 + L_1)(L_2 + R_3 + R_2) + L_2R_2 + R_2R_3} \qquad (4)$$

$$I_2 = \frac{I_1(L_2 + R_3) - G_2}{L_2 + R_3 + R_2} \qquad (5)$$

$$I_3 = I_1 - I_2 \qquad (6)$$

These expressions look complicated, but the choice lies between using them or by solving (a), (b) and (c) which actually give (4), (5), and (6) as results. The easier way, then, is to use (4), (5), and (6) to start with and obtain numerical results from them. These equations may be simplified if $G_1 = G_2$ (as it usually does), and $R_1 = R_2 = R_3 = R$ (as it often does). Substituting these equivalents in (4), (5), and (6) gives:

$$I_1 = \frac{G_1(3R + L_2)}{(R + L_1)(L_2 + 2R) + R(L_2 + R)} \qquad (7)$$

$$I_2 = \frac{I_1(L_2 + R) - G_1}{L_2 + 2R} \qquad (8)$$

$$I_3 = I_1 - I_2 \qquad (9)$$

Suppose that $R = R_1 = R_2 = R_3 = 0.05$ ohm as before; that $G_1 = G_2 = 100$; that $G_T = 200$; and that the resistance of L_1 is 1000 ohms and of L_2 is 10 ohms. Equations (7), (8) and (9), with these numerical substitutions, become:

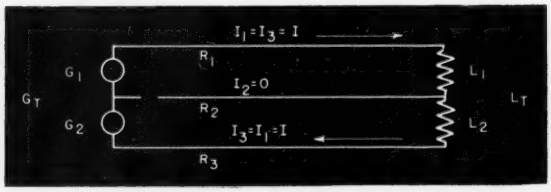


Fig. 2. The Edison three-wire system with the neutral open

$$I_1 = \frac{100(0.15 + 10)}{(0.05 + 1000)(10 + 0.1) + 0.05(10 + 0.05)} = 0.10 \text{ amp.}$$

$$I_2 = \frac{0.10(10 + 0.05) - 100}{10 + 0.10} = -9.80 \text{ amp.}$$

$$I_3 = 0.10 - (-9.80) = 0.10 + 9.80 = 9.90 \text{ amp.}$$

The negative sign for the value of I_2 is not indicative of an error, but means simply that I_2 flows from C to D instead of from D to C as was assumed. The equations (7), (8) and (9) and (4), (5) and (6) were all obtained from other equations set up for currents flowing as shown in Fig. 1 and must be used with that assumption. Then, if I_2 comes out negative, that current actually flows from the supply instead of toward it, and its value must be added to that of I_1 to obtain I_3 instead of subtracted from it. The answer is numerically correct, however. The values obtained may be checked by means of the voltage drops around the system.

Neutral Should Not Be Fused

One problem that confronts some wiremen is the question of whether or not the neutral wire (the wire carrying current I_2) should be fused. All wiring codes specify that it must not be and many wiremen cannot understand the reason for it. Sup-

pose that the same values of resistance are used as in the illustration of the use of equations (7), (8) and (9), this time, in connection with Fig. 2 which shows a three-wire system with the neutral wire broken as it would be if it were fused and the fuse blown. Now, $I_1 = I_3$, and $I_2 = O$, because no current can flow in the broken neutral wire. Using Fig. 2 and the laws of the electric circuit:

$$IR_1 + L_1I + L_2I + IR_3 = G_T \qquad (d)$$

$$I = \frac{G_T}{R_1 + R_3 + L_1 + L_2} \qquad (10)$$

Substituting the values given:

$$I = \frac{200}{0.05 + 0.05 + 1000 + 10} = 0.198 \text{ amp.}$$

The voltage across the loads are then:

$L_1 = (1000)\ (0.198) = 198$ v.
$L_2 = (10)\ (0.198) = 1.98$ v.

From these results it can readily be seen that any equipment between B and D of Fig. 2 would burn out very rapidly, while any equipment between D and F would have so low a voltage across its terminals that it would not operate. For this reason and the fact that the extremely high voltage across BD may endanger surrounding property or even life, the neutral of the three-wire system is always solid from supply to load and never fused.

E. E. I. Convention Program of Wide Scope

BY THE TIME this issue is mailed, the Eighth Annual Convention of the Edison Electric Institute will be in progress at Atlantic City. Scheduled for June 3 to 6 inclusive this meeting promises to rank high in comprehensiveness and interest. At one or the other of five general sessions, the special evening session and the luncheon meeting practically every activity of major importance to the electric industry will have its turn beneath the spotlight, as well as more general subjects of vital interest to every American business man. The speaker in each case will be an authority in his particular field.

Among those who will speak on subjects of broad general interest are Mr. Howard Coonley, chairman of the board, National Manufacturers Association; Dr. Lionel Edie, consulting economist, and Colonel Robert S. Henry, assistant to the president, Association of American Railroads.

Included in the speakers representing the electrical industry are: Mr. Alex Dow, The Detroit Edison Company; Mr. Samuel Ferguson, The Hartford Electric Light Company; Mr. Paul M. Downing, Pacific Gas and Electric Company, San Francisco, Cal.; Mr. C. L. Campbell, Connecticut Light and Power Company; Mr. Edwin Vennard, Middle West Service Company, Chicago; Mr. H. R. Woodrow, Consolidated Edison Company of New York, Inc.; Mr. E. L. Hopping, Philadelphia Electric Company; Mr. George Ousler, Duquesne Light Company, Pittsburgh, Pa.; Mr. H. L. Wallau, The Cleveland Electric Illuminating Company.

Mr. Kinsey M. Robinson, The Washington Water Power Company, Spokane, Wash.; Mr. James M. Stafford, Jr., Georgia Power Company, Atlanta; Mr. W. F. Nimmo, Virginia Electric and Power Company, Richmond, Va.; Mr. C. E. Kohlhepp, Wisconsin Public Service Corporation, Milwaukee; Mr. Bernard S. Rodey, Jr., Consolidated Edison Co. of New York, Inc.; Mr. F. A. Newton, The Commonwealth and Southern Corporation; Mr. H. P. Liversidge, Philadelphia Electric Co.; and Mr. C. W. Kellogg, president of the Institute.

The electrical manufacturers will be represented by Mr. Ralph Kelly, vice-president, Westinghouse Electric and Manufacturing Company, and Mr. C. E. Wilson, president, General Electric Company.

Five general sessions, an evening and a luncheon meeting are scheduled for Convention week. The first will open promptly at 9:30 a. m., Tuesday, June 4, with another session in the afternoon of the same day. Two general sessions—morning and afternoon will be held Wednesday, June 5, with a special session the evening of the same date. The concluding events will be a morning session, and a luncheon meeting at the Hotel Traymore, Thursday, June 6.

Friday, June 7, has been designated as Edison Electric Institute Day at the Fair, and Convention visitors will be especially welcomed at the many fine exhibits in the electrical section of the grounds. In order that delegates may travel direct from the Convention after its close to the Fair, a special train will be operated from Atlantic City to New York Thursday, leaving Atlantic City at 2:55 p. m. and arriving New York at 5:40 p. m., Standard Time.

A cordial invitation is extended by Mr. C. W. Kellogg, president of the Institute, to all electric utility companies including non-members of the Institute and to electrical manufacturers.

High Pressure Reduces Power Costs in Industrial Plant

Continued from Page 58

stepped up to 13,000 by an outdoor transformer station and at the Marshall plant, a half mile away, it is stepped down again to 460.

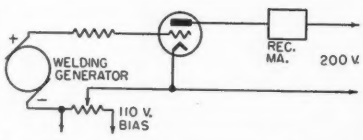
From the standpoint of performance the data provided by the manufacturers has been exceeded and the over-all efficiency has reached 83.6 per cent for a weekly average. More significant, however, are the results of operation expressed in terms of direct savings in the fuel bill. According to F. H. Cronin, the chief mechanical engineer of the National Vulcanized Fibre Co., in the two years that the new equipment has been in operation power has been furnished to the mill at a cost of no additional energy over the old fuel bill alone. Of course it must be understood that a larger and more competent operating personnel had to be employed which increased the power house operating pay-roll over the old one slightly. It is believed that the new plant will pay for itself in about four years, due to the direct saving in purchased power alone.

Here is an article that should be of particular interest to those concerned with the practice of arc welding in any of its various applications. The author discusses a method whereby the skill or the technique of the operator can be accurately measured. By means of an instrument known as the Arcronograph every variation in the uniformity of the arc stream is accurately recorded. The resulting record can then be interpreted in terms of the operator's skill or the quality of the weld. The instrument is simple to use and it should be a great aid in developing and improving the skill and the technique of the operators.

Measurement of Arc Welding Technique

By HAROLD S. CARD

DURING its initial period of development the arcronograph had for its objective the production of a record which would be useful in grading various types of metallic arc-welding electrodes. In view of the many tests which have been devised for the determination of the physical properties of deposited metal, this addition of a new method might seem superfluous to the casual observer; but the revelation which this instrument gives of the welding arc's behavior under the influence of varying factors (electrode core material, electrode coating, voltage, current, operator proficiency, etc.), promises a broad range of unique service to fabricators whose weld-quality requirements are high.



THE PRINCIPLE of the Arcronograph is shown in this simplified wiring diagram. It consists of an electron tube amplifier and a recording milliammeter so arranged that it records the mathematical mean of the time relationship of the high and low potential periods of the arc. The input terminals are connected across the welding generator as shown, with a 100 v. bias supply connected in the negative lead. By means of the bias voltage control, the plate current is adjusted to cause full swing of the recorder whenever the arc voltage reaches a maximum for a given electrode. During periods of low potential the grid is not energized positively enough to cause any plate current to flow; consequently the recorder seeks its zero position. The recording element, however, has a certain small inertia which prevents it from following the rapid variation in voltage across the arc. It, therefore, assumes a position which is the mathematical mean of the time relationship of the high and low potential periods of the arc. If the strip chart upon which the stylus of the indicator rests is divided into 100 parts then a record of 60 means that for 60 per cent of the time elements during welding, the pointer tended to swing out fully to the right (maximum voltage) and during 40 per cent of the time it tended to return to zero. Auxiliary circuits not shown in the diagram make the instrument fully automatic so that it starts when welding starts and stops when welding stops.

The nature of the arcronograph record can be explained briefly by considering arc deposition to consist of a stream of molten globules, or drops flowing from the tip of the electrode into the molten crater that has been formed on the parent metal. The life cycle of each drop consists of a formation period and a deposition or transfer period. What the arcronograph records is the time ratio of the formation period to the complete life cycle of the drop. The continuous record of these ratios throughout the period of deposition of a complete electrode tells the story of the uniformity of the arc stream.

Since it is manifestly impossible to maintain an absolutely uniform ratio, the record obtained is necessarily a wavy line, traced by a vibrating stylus. For a given set of conditions, a definite range can be allocated to the amplitude of these vibrations, and to their position with reference to a fixed line on the chart, within which the voltage and current characteristics of the arc are ideal for the production of a perfectly sound deposit; whereas, amplitudes beyond the borders of the ideal range suggest the presence of defects in the weld.

Of great assistance in interpretation is the fact that the maintenance of optimum arc conditions is reflected in a rhythmic movement of the recording stylus. This rhythmic character in the graph may

thus indicate that the operator has good muscular coordination and skill in maintaining a uniform arc length. However, the graph may be too far to the right or to the left of the optimum line, indicating that the arc length, even though it be commendably uniform, is too long or too short. Or, it may start in the proper range and gradually incline to the left, indicating that the operator has a habit of allowing his arc gap to shorten as the electrode is consumed.

It is apparent that a record of this nature has several useful and distinctive features. Among them: a complete and permanent graphical representation of the uniformity of the arc stream throughout the deposition history of each electrode; definite location of every point where the arc was either broken or shortcircuited; incorrect arc lengths, either temporary or sustained, plainly shown in relation to the optimum arc gap; the arc manipulation habits of the operator under various conditions are indicated with great clarity.

No engineering knowledge or skill is required to interpret so simple a record after the optimum has been established; in fact, welding operators learn rapidly to diagnose their own faults after being shown that a rhythmic graph close to and parallel to the optimum line, indicating ideal voltage conditions, signifies a clean, sound deposit; and conversely, that a randomly wandering graph will be associated with a sub-standard weld. The fault is not always with the man at the arc. Unsatisfactory results can just as readily be traced to poor design of the electrode, to using the wrong technique with a good electrode, or to lack of balance between the welding machine and the electrode.

The welding technician will recognize that these observations all derive from the effect of arc gap length: too long a gap increases the voltage, lowers the heat and unduly prolongs the period of heating of the parent metal; too short a gap decreases the voltage and melts the electrode too rapidly in proportion to the melting rate of the parent metal.

Portions of two arcronograph investigations have been selected to illustrate respectively, (1) the effect of changing technique (Figs. 1 to 3), and (2) comparison of two different operators supposedly equal in skill, using the same technique (Figs. 4 to 7).

Figure 1 is the deposition history of a 3/16-inch heavily coated electrode at 30 v. and 225 amp. It is

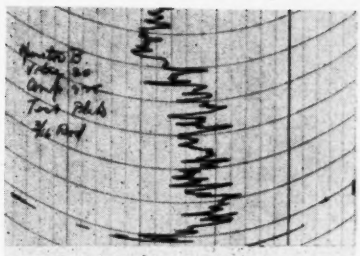


Fig. 1. Deposition history of a 3/16 in. heavily coated electrode at 30 v., 225 amp. Optimum line, 90. Steady band but arc too short.

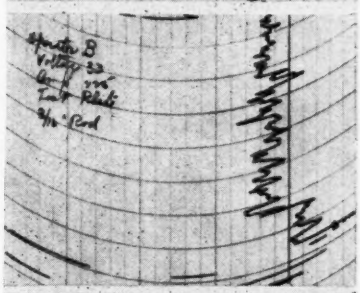


Fig. 2. Same as Fig. 5 but voltage raised to 33. About 1/4 of electrode was laid down with arc gap too long. Then operator settled into a well balanced performance

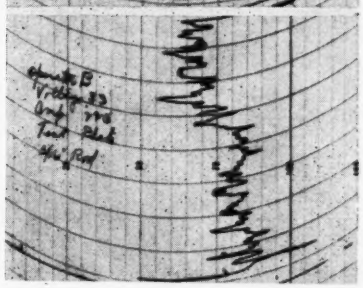


Fig. 3. After changing electrodes, operator started with very nearly correct gap, but he shortened his arc gradually and hurried deposit

the best of three attempts made by this operator using 30 v. at the arc. The optimum line in this case is the 90 line. So much of the graph is well to the left of this optimum, that one would be certain to find in the deposit all of the characteristic defects of the short arc. Yet the amplitudes of vibration are not excessively wide, indicating that the operator holds a fairly steady arc although he tends to make it too short.

An attempt was made to improve this operator's showing by raising the voltage to 33 v. Figure 2 is the record of the first electrode with the changed technique. About one-fourth of the electrode was laid down with the arc gap too long. Then the operator suddenly settled into a well balanced perform-

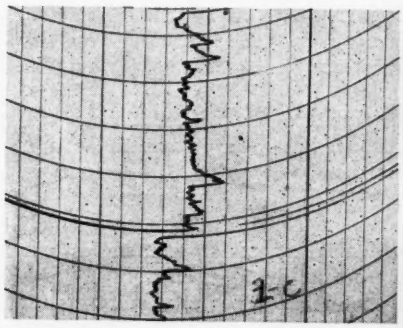


Fig. 4.

Fig. 5.

Fig. 6.

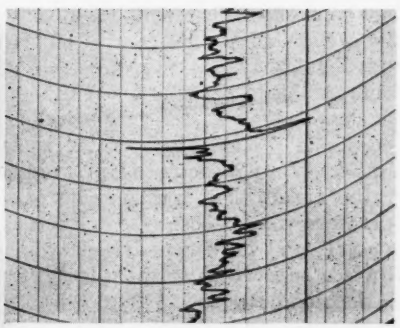


Fig. 7.

ance and held it steadily until the electrode was consumed. Welding time for the electrode represented by Fig. 2 was 85 sec.

When this operator changed electrodes again, he started with very nearly the correct gap. But he shortened his arc gradually and hurried the deposit, with the result shown in Figure 3, an erratic and probably porous deposit, piled up instead of penetrated. Welding time was 75 sec. The voltage change made some improvement, but the operator revealed a bad habit in spite of his ability to hold the arc steadily.

In the second investigation here illustrated, two operators welded a ¾-inch test plate using the same machine, electrode and current setting. The plate edges were beveled to form a single V. Operator A welded one half, depositing five beads and one weaving layer; then Operator B welded the second half, depositing three beads and two weaving layers. The arcronograph was adjusted for the voltage across the arc which would make the optimum readings occur at the 75-80 range. Since one purpose of this investigation was to select operators who could qualify for Class I welding, the test plates were X-rayed upon completion.

The story of a typical bead deposited by Operartor A is found in Fig. 4. About all that can be said about this arcronograph is that it is so nearly perfect that it furnishes a standard for comparison. This statement would not be conclusive without evidence of the soundness of the weld. Figure 5 is the radiograph, and shows it to be practically flawless. (Unfortunately it is not possible to reproduce X-ray films on the printed page and bring out much of the contrast which is visible on the film itself when shown in the shadow box. The accompanying reproductions should therefore be interpreted with the reservation that their diagnostic value is about 20 per cent that of the original films.)

Operator B did not perform so well. Figure 6 is the record of his third pass. Comparing this arcronogram with Fig. 4, it will be seen that Operator B was erratic in his manipulation, that he advanced more slowly and deposited a large enough bead to consume nearly one and one-half electrodes in making this pass, that the amplitudes for some distance show the steadiness which comes with experience, that when about two-thirds through the first electrode he suddenly went wild and continued with poor control for the remainder of that pass. (It took him six seconds to get control of his arc. Two seconds should have sufficed.) The radiograph in Fig. 7 confirms this interpretation. The film would readily be classified as showing "borderline porosity, unacceptable". Yet this operator is far from being hopeless. Borderline porosity is indicative of better craftsmanship than is usually found among welding operators except those who are accustomed to welding on Class I work or under X-ray control. Operator B needs supervised practice to bring his skill back to the required grade.

If it were desired to select a small group of the best welders from a large number, for a project requiring special skill, or to eliminate from a number of applicants all those who lacked a certain degree of proficiency, there would be little difficulty in making up a guide set of arcronograms with correlated radiographs indicating the degree of soundness corresponding to typical arcronograms. Rating could then be established directly from the graphs, with reasonable certainty that the successful operators would pass all standard qualification tests.

A complete arcronograph record may also be useful for checking work which cannot be radiographed satisfactorily, such as welding nozzle connections on boilers and pressure vessels. Defects can be located immediately when they occur, and be shipped out, instead of being covered by following beads or layers. In numerous cases this would probably mean the use of a smaller amount of weld metal of known quality instead of a larger amount of weld whose soundness depends upon the responsibility of the operator and the good judgment of the supervisor.

In conclusion, the writer finds in these investigations an interesting verification of the influence of arc gap length on weld quality. The utility of this graphic picture of arc performance lies in the fact that the inspector can tell how many faults were made during the period covered by the record, where the faults are located, and what probably caused them. No attempt has been made here to speculate upon how many applications there might be for this unique instrument, but only to present some interpretations of typical arcronograms, and compare these with the findings of X-ray inspection as a check on their dependability.

Vibration—Its Effect on Heat Transfer

Continued from Page 44

of the tube were doubled (to 1.5 inches), the Reynolds' modulus would become 300 and the value of Nu would still be unaffected by the vibration.

Tests using more viscous media such as oils instead of water have not yet been accomplished, but since the expression for Re involves the viscosity μ in the denominator, more viscous media would correspond to lower magnitudes of Reynolds' modulus for the same intensity of vibration.

Convection In Air:

If a body is losing heat to air by free convection, approximately seventy times the vibrational velocity is necessary to produce the same Re as would be required with water[11].

Increase in the rate of condensation due to vibration is not yet known but awaits experimentation. The same statement may be made with respect to rates of boiling[6].

From the above considerations we may conclude that in a well designed central station, increase in the rate of heat transfer due to vibration in those units in which transfer is by free convection, is extremely improbable. In the case of heat transfer units in which the transfer is by forced convection, the effect of vibration will be still smaller.

The PRACTICAL ENGINEER and ELECTRICIAN

R. H. MORRIS, EDITOR

CHANGING THE GUARD

CONSIDERING the drift of world events this seems like a propitious time to patch up the old uniform, brush up on a well forgotten military vocabulary and add a few terms introduced during the last 20 yr. This must wait, however, until the new P.E.&E. editor has been properly introduced, for not even war and rumors of war can be allowed to interfere with the fine old traditions.

Mr. Kramer explained in the December issue the reason for the periodic change of editors and for the next 6 mo. the entire responsibility for the issue from stem to stern falls upon the broad and honest shoulders of Ralph Turner. To the old timers he needs no introduction but we feel that the many newcomers will be interested in knowing a bit about him, things which we know his natural modesty will not allow him to tell.

As a young Nebraskan he herded cattle on the family homestead where the Columbus reservoir now stands and received his early education in a country school. As a young man, printers ink got in his blood as he worked on his father's country newspaper. This did not, however, keep him from working his way through the University of Nebraska nor, as a footloose and fancy free young electrical engineer, doing his best to help Mr. Westinghouse establish the electrical industry by earnest efforts in the shop and as trouble shooter on the road.

Printer's ink proved stronger than electricity, however, and before many years he was back in the publishing field, this time on the editorial staff of the Practical Engineer (changed in 1917 to Power Plant Engineering) as assistant to Mr. Rice. Soon after this he became managing editor and in 1938 editor. Belonging to the N.A.P.E. (Ill. No. 1), the Western Society of Engineers, and the A.S.M.E., he has always taken an active part in society affairs and is a past chairman of the Chicago section of the latter.

He is short and stocky, a bit conservative in his tastes, with a deep sense of responsibility levened by a keen and droll sense of humor. All in all he is a fine fellow to work with, and for, and you will enjoy his handling of the P.E.&E. section for the next 6 mo.

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A Section of Power Plant Engineering Devoted to
PLANT OPERATION AND MAINTENANCE

Technical Publishing Company
53 West Jackson Blvd., Chicago, Ill.

A Little Education—

Missing the opportunity of a "sugar coated" education in regular school or college is no excuse to throw up your hand in despair, but regardless of education don't spurn the correspondence course and evening classes. Individual university extension service enrollments run as high as 40,000, spread over 200 low cost courses ranging from grammar school to college graduate levels and available anywhere there is a mail box. It's a hard way, requiring determination, patience and persistence, but not even the most advanced advocate of "lollypop" education in the regular school system has found a short cut to learning. Education does not make an engineer—it simply supplies a set of tools which the individual must learn to use through practice. The better the tools, the man and the practice—the better the engineer.

THAT "a little knowledge is a dangerous thing" is nowhere more true than in the engineering field where inadequate data and rule of thumb methods may well involve a grave potential personal and property hazard. Professional pride not infrequently brushes mathematics, the Queen of the Sciences, from her snug berth to boast with a false sense of security that "Engineering is an exact science."

While engineering is based on a relatively few fundamental scientific principles arrived at deductively by experimental data over a limited range, there is some question as to whether the practical application of these principles by the engineer should be considered an art or a science.

The Two Groups

If no progress were being made the danger of rule of thumb methods would be lessened but the margin of experimental error which separates theory from practice and brings the art of engineering closer to a science, is constantly narrowing. Where an engineering education was once only desirable, it is now imperative. The man who knows nothing never doubts; the man who knows little has a supreme confidence in himself; while the man who knows the most is the cautious and skeptical for he has an inkling of how superficial much of our knowledge actually is.

This transition from the confident to the skeptical stage is apt to prove a rude jar to the man who came up through the "College of Hard Knocks" but it is perhaps as good a point as any to draw an illusory dividing line between the uneducated and educated engineer. Every practicing engineer uses rule-of-thumb and short cut methods but until he is able to use these with discretion, with full appreciation of their limits and probable accuracy under given conditions, he can hardly lay claim to being educated, with the ability to reason as contrasted to a human encyclopedia stuffed with unrelated facts.

How this education is obtained is unimportant provided it is used. The active dislike of the practical engineer for the textbook engineer is largely the result of short sightedness on both sides. The latter is apt to forget that "knowledge is a treasure but practice is the key to it" and that he lacks a key. The former is apt to envy the treasure and completely overlook the fact that he has the key, infinitely more important and harder to get than the treasure itself. The treasure lies neatly bound in accessible books, the key must be forged by hours of experience which require both the will and the opportunity.

Class Work Is Best

Next to a regular school or college, night classes are most desirable for the personal contact with instructors and fellow students and the advantage of shop and laboratory work is important. These are available in practically every large city, either in private or public schools, in many cases as cooperative or extension classes of state universities.

Next is the correspondence course which will be covered in greater detail later. Finally, there is home study from textbooks, not at all impossible, but the most difficult for the contact with, and advice of, the instructors is missing and such study is often made without plan or adequate preliminary training.

Should you be skeptical of correspondence courses, consider a moment. These were started in a comprehensive way in college by the University of Chicago about 1892, almost half a century ago. Among the colleges and universities this developed rapidly and a national association now has some 52 member institutions. Correspondence course enrollments in this group alone run over 60,000 a year.

Directories and Advice

A complete list of member institutions with a guide to the courses offered by each can be obtained for 10 cents per copy from W. S. Bittner, Secretary, National University Extension Association, Indiana University, Bloomington, Ind. Inasmuch as courses are offered in accordance with the demands of the general public, many of the institutions offer a rather restricted range of strictly vocational courses but this need is met by a number of commercial and private schools.

There are no national public accrediting agencies in correspondence teaching and selection of a vocational school is a serious problem. For guidance in choosing among the better type of private and trade association schools, the National Home Study Council, 839 Seventeenth St., N. W., Washington, D. C., is recommended by Mr. Bittner. This council also cooperates in the difficult task of preventing the activity of the more flagrant commercial exploiters.

The accompanying table lists some of the association member schools that offer engineering and vocational courses closely related to power plant engineering, or, fundamental courses such as mathematics, physics, chemistry, drawing, etc. As a rule, courses are listed and must be taken separately in the proper order, although in a few cases necessary elements of mathematics, physics, mechanics, thermodynamics, etc., are combined with a certain amount of practical application to form a vocational course. A somewhat more complete example of this is the Shop Engineering Course offered by Rutgers University. This incorporates seven individual courses at a combination price of $36 and has no prerequisites beyond a grade school education.

Many schools give a diploma or certificate for satisfactory completion of a comprehensive course. The Massachusetts University Extension (J. A. Moyer, the director, is a well known engineer and author by the way) offers diplomas in Electrical, Mechanical, Civil and Aviation Engineering for the satisfactory completion of 60 semester hours of work. From 44 to 50 hr. are definitely specified so as to give a well rounded education comparable to a regular school course, the balance may be selected from a comprehensive list of electives.

Similar suggestions regarding eight comprehensive engineering courses are given on pages 43-46 of the Penn State bulletin. In addition to the three schools mentioned above, Michigan, Wisconsin, North Carolina and California offer the widest range of practical engineering courses and the best selection of evening classes in different cities in the states. This cannot, however, be taken too literally for isolated courses of a specialized nature may appear most anywhere. Kanssa, for instance, offers a comprehensive course on engines and boilers (No. 75c, $10); Kentucky, on practical mining ($15); Ohio, accoustics (No. 125, $12) and illumination (No. 133, $12); Wyoming, automobile mechanics; Oregon, stresses and structural design; and Washington a variety of cost accounting.

In planning a course, catalogs of the regular college are of interest as a practical guide for they show the extent, direction and arrangement of the regular engineering courses year by year. Most schools will give advice on the selection of courses but in the long run the student must plan for himself and lay out a course of education to meet his own needs.

Selection Often Confusing

In spite of all this help, however, the average engineer wishing to increase his knowledge will find the selection and planning of a course of

study confusing, but because of the differences in training, experiences, previous education and personal requirements advice of only the most general type can be given. This must, of necessity, be made on: the assumption that the prospective student is seriously interested in his future; that he wants a fundamental education; and that he will do his own thinking and reasoning. The man who invests $5 today in the expectation that all the answers to all his practical problems will be handed to him on a silver platter so he can demand, and get, a $5 raise from the boss tomorrow is doomed to disappointment. The answers don't come in books. Books supply only the raw material which, leavened with experience and mixed with grey matter, produces the answers in the mind.

You Must Be Able to Read and Write

First of all, practically all information is conveyed by words and in this country the ability to read, write, speak and understand the English language is the first step to an education. To learn, it is necessary to understand what others say or write. Both presuppose a reasonable general vocabulary and a smaller specialized vocabulary which varies considerably with the vocation. Success in many jobs is conditional upon the ability to make oneself understood and to write a concise intelligent report.

The inability to do this is not limited to the man who has had limited schooling, it is one of the common complaints by and about college graduates. Therefore, a course in English is not amiss, not English literature or poetry but good old fashioned grammar. Plain English, a $6 course offered by Massachusetts University Extension, can be recommended from first hand knowledge. Another example is

A partial list of universities offering correspondence courses. A dagger (†) indicates those schools offering the largest selection of courses of probable interest to engineers. Costs are approximate, for while an effort was made to reduce them to a uniform semester-hour basis this has little meaning. The University of Arkansas semester hour course for instance consists of 8 lessons, the University of California of 15. Sometimes textbooks are included, sometimes not. Most courses are from 2 to 4 semester hours and cost accordingly. In a few cases a registration fee as well as tuition is required and this is indicated as $10 + $2, the first being the tuition, the second the registration fee which is sometimes charged only once in other cases once each semester. In general no distinction is made between residents and non-residents in the state although in other cases a slight additional charge is made as indicated in the NR (non-resident) column. Extension class work is also offered by most schools usually in several of the larger cities of the state, the general policy being to organize classes wherever there is sufficient demand. Some colleges provide a partial or complete library rental service for text and reference books as indicated in the last or L column. Specific courses can be located in the complete guide mentioned in the text.

COLLEGE	LOCATION	COURSES OFFERED										Cost s. hr.	NR	L
		D	C	P	Mh	ME	EE	Hy	AC	DE	Rf			
University of Alabama	University, Ala.	X	X	....	X	X	....	....	....	....	....	$4.00	same	....
University of Arkansas	Fayetteville, Ark.	X	X	....	X	X	X	X	....	....	....	4.00	same	X
University of California†	Berkeley, Cal.	X	X	X*	X	X	X	X	....	X	....	7.00	$3 add.	X
University of Chicago†	Chicago, Ill.	....	X*	X*	....	....	....	X	....	....	....	10+2	same	X
University of Colorado†	Boulder, Colo.	X	X	X	X	X	X	X	....	X	X	3.50	same	X
University of Florida†	Gainsville, Fla.	X	X	X	X	X	X	....	....	....	....	3.50	$1 add.	X
University System of Georgia	Atlanta, Ga.	....	....	....	....	....	....	X	....	....	....	5.00	same	....
University of Illinois	Urbana, Ill.	X	....	X	X	....	X	....	....	....	....	5.00	same	....
University of Indiana	Bloomington, Ind.	....	....	....	....	....	....	....	....	....	....	5.00	same	X
University of Iowa	Iowa City, Iowa.	X	X	X	....	....	....	....	....	....	X	4+2	same	X
University of Kansas	Lawrence, Kan.	X	X*	X	....	X	....	....	....	....	....	3.00[1]	$1 add.	X
University of Kentucky	Lexington, Ky.	....	....	....	....	....	....	....	....	....	....	4.00	.....	X
Louisiana Polytechnic Institute	Ruston, La.	X	....	....	....	X	X	....	....	....	....	3.00	same	X
Louisiana State University	University, La.	X	....	X	....	....	....	....	....	....	....	4.00	same	X
Massachusetts Department of Education†, [2]	Boston, Mass.	X	X	X	X	X	X	X	X	X	X	3 to 6	$5 to 10	....
University of Michigan†	Ann Arbor, Mich.	X	X	X	....	....	X	....	X	X	....	2.00	$5.00	....
University of Minnesota†	Minneapolis, Minn.	X	....	X	X	X	X	....	X	X	X	3.50	same	....
University of Missouri	Columbia, Mo.	....	X	X	....	....	....	....	....	....	....	4.00	same	X
University of Nebraska	Lincoln, Neb.	X	X*	....	X	....	....	....	....	X	....	5+1	same	X
North Carolina State College†	Raleigh, N. C.	X	X	....	....	X	X	....	X	X	....	2.50	same	....
North Dakota Agricultural College	Fargo, N. D.	....	X*	X	....	....	X	....	....	X	....	2.50	same	X
Ohio University	Athens, Ohio.	X	X	X	....	....	X	....	....	....	....	6.00	same	X
Oklahoma A. & M. College	Stillwater, Okla.	....	X	X	....	....	....	....	....	....	....	.....	same	....
Oregon State System of Higher Education[3]	Eugene, Ore.	X	....	X	....	....	....	....	....	....	....	2.50	$5 reg.	....
Pennsylvania State College†	State College, Pa.	X	X	....	X	X	X	X	X	X	X	4.00	.....	X
Rutgers University†	New Brunswick, N. J.	X	....	....	X	X	X	....	X	....	X	5.00	same	....
University of Tennessee	Knoxville, Tenn.	X	....	....	X	X	X	....	....	....	X	4.00	same	X
Texas Technological College	Lubbock, Tex.	X	....	....	....	....	....	....	....	....	....	5.00	same	X
University of Utah	Salt Lake City, Utah.	....	....	X	....	....	....	....	....	....	....	2.50	same	....
University of Washington	Seattle, Wash.	X	....	....	....	X	X	....	....	....	....	4.00	same	X
University of Wisconsin†	Madison, Wis.	X	X*	X	X	X	X	X	X	X	X	5.00	$8.00	....
University of Wyoming	Laramie, Wyo.	....	....	....	....	....	....	....	....	X	....	2+1	4+1	X

NOTES: D, drawing; C, chemistry; P, physics; Mh, mechanics; ME, mechanical engineering including thermodynamics and power plants; EE, electrical engineering including radio; Hy, hydraulics; Ac, air conditioning, heating and ventilating; DE, Diesel and automotive engines; Rf, refrigeration. An asterisk (*) in the chemistry and physics column indicates that laboratory courses are offered. A (†) indicates the schools with the widest selection of engineering courses. All schools offer a wide range of English and mathematics courses. [1] $10 minimum. [2] Div. of University Extension, State House, Boston. [3] Includes Oregon State Ag. College and the U. of Oregon.

Penn State English, which covers the essentials of grammar, vocabulary building and related subjects. Practically all other colleges offer comparable courses. Many also offer technical writing courses often under the heading of Journalism. An example of this is course 17C, Technical Writing ($10) offered by the University of Iowa.

Equally important is the matter of drawings and blueprints, the shorthand of engineering expression. A knowledge and understanding of drawing is an engineering essential. While some will find a brief course in blueprint reading (offered by Massachusetts, Michigan, Penn State, Tennessee and Wisconsin) entirely adequate, most engineers will find an elementary course in drawing, covering the use of instruments and the various kinds of projection, well worth while. A few will want to continue on to the more advanced courses which merge into machine design and graphical solution of certain engineering problems.

Can Others Read Your Hand Writing?

In somewhat the same category comes typing, not essential but often a useful accomplishment, one which we as editors can say most engineers need. A secondhand typewriter can usually be picked up for a few dollars and an instruction manual for a dollar or at most a dollar and a half.

Next, and perhaps most difficult to deal with, is mathematics. Most engineers use a smattering of arithmetic, algebra, geometry and trigonometry more or less regularly, a few have an occasional use for calculus, perhaps vector analysis and complex numbers as well. The importance of mathematics to the engineer, however, is not in the actual use he makes of it in his work but the use made of it in the process of learning other subjects.

From its very nature, engineering must be, or can easiest be, learned from a mathematical treatment. The average student will go to an engineering college with algebra, plane and solid geometry and plane trigonometry, perhaps with a dash of spherical trigonometry (used in navigation) and will continue on with analytical geometry, differential and integral calculus, differential equations and, in an electrical course, perhaps vector analysis and complex numbers. Some colleges include descriptive geometry, really a drawing course, dealing with the graphical solution of structural and mechanical problems and the intersection of planes and solids. This all means 7 to 8 yr. continuous study, obviously out of the question for all but regular students.

Inasmuch as most men in the engineering field have had some courses in mathematics or picked up some here and there, a study of "Mathematics for the Practical Man" by George Howe, published by D. Van Nostrand Co. of New York and selling for $1.50 will prove of material assistance. This is a small book of 135 pp. explaining simply and quickly the elements of algebra, geometry, trigonometry, logarithms, coordinate geometry and calculus, with problems and answers—all written for the practical man with a knowledge of machinery.

While it will not turn out finished mathematicians, it does give a comprehensive understanding of the mathematics necessary to follow technical books and appreciate and understand the development. Those who lack even a good working knowledge of arithmetic should first carefully work through any grammar school arithmetic or take a course such as Shop Arithmetic 850a (20 lessons, $8) offered by the University of California.

After reading Howe's book, one will be in a good position to judge what further course in mathematics is advisable to meet his own needs. Many engineering courses specify definite mathematical prerequisites, particularly physics and thermodynamic courses. To meet this mathematical need by those lacking complete mathematical training, a composite preparatory course is offered by some colleges, Course CMs, 23 Basic Mathematics ($14) by the University of Florida is an example. This course gives a working knowledge of algebra, trigonometry, geometry and some calculus as needed for a study of the basic sciences, presents mathematics as an integrated whole, and shows its correlation to other subjects.

Chemistry and Physics

Two other subjects, chemistry and physics, bear somewhat the same basic relation to engineering as does mathematics. Combustion, feedwater treatment, lubrication and many industrial processes involve more or less chemistry. Physics is the fundamental science that embraces practically the entire range of mechanical and electrical engineering, mechanics, electricity, magnetism, heat, light and sound. Both are desirable before beginning more specialized work in order to get a general picture of the field and to acquire a technical vocabulary. Many vocational courses will include a smattering of each but this lacks the systematic continuity of a general elementary course.

The trend of education should be from the general to the specific, that is first become familiar with the tree trunk that supports all, then the larger branches and finally with the smaller twigs. A student in a regular school course intending to specialize in refrigeration will study it first in physics as a subdivision of heat, then as an important part of thermodynamics and finally as refrigeration, thus building up a supporting framework with each part well tied in with its neighbor. The "short cut" student must eliminate the supporting framework and his education consists of a collection of unrelated facts, each standing alone, difficult to remember and difficult to apply for there are no connecting links.

Unfortunately these basic sciences, mathematics, chemistry and physics, cannot be learned well from a book alone, for the eyes, the mind and the hand cannot be trained to work together without a workshop or laboratory. With mathematics this is simple for only a pencil and paper are required. The other two require rather elaborate and expensive equipment so that where possible they should be learned in a classroom with laboratory equipment. There are, however, several schools, indicated by an asterisk in the table, that offer these courses and have laboratory equipment which can be rented cheaply, although a deposit of from $25 to $50 is required.

Fundamentals First

A chemistry course equivalent to the usual high school course is essential for power plant work and many will find it advantageous to go a step farther into quantitative chemistry, a few even into organic chemistry. In physics the equivalent of a high school course is better than none but the more comprehensive course as given in the freshman year of college, covering the complete range of mechanics, heat, light, magnetism, electricity and sound is desirable.

With this background the more specialized courses such as mechanics, mechanisms, thermodynamics, hydraulics, electricity, refrigeration and air conditioning, internal combustion engines, etc., can be tackled with ease and confidence, if necessary by the aid of a textbook alone. These applied engineering correspondence courses are limited and offered by only a few of the colleges most of which are indicated by a dagger (†) in the table. While laboratory work is often desirable in these applied courses, this need can often be fulfilled, for the practical student with imagination, by the plant in which he works. To meet the somewhat specialized needs of the student interested in civil service and license examinations, Massachusetts offers 11 courses including preparation for electricians, plumbers, mechanics and third class engineers.

Thus ends both the article and, temporarily for at least a year, my career as editor of P. E. & E. I retire to plain engineering editor of P. P. E. with regret and full appreciation of the part you have played in making the last six months a period of satisfaction, for fan mail is as welcome to an editor and author as to a movie actor. Deeply conscious, however, of having broken a solemn promise never to let a P. E. & E. article run over 2 pages, I wait with bared breast the storm of righteous criticism, buoyed up only by the conviction that the steady stream of requests for advice on education seemed to justify the space used, and by the knowledge that Mr. Turner, burdened as he is with responsibilities, will during the next six months make amends for my transgressions.

R. H. Morris

APRIL $25 PRIZE CONTEST

Entries in the April contest covered the entire gamut of emotions from humor, through pathos to tragedy and continued well into the realm of reality so necessary in an engineer's everyday practical duties. One entry, however, was outstanding because it dealt with fundamental requirements for success in any walk of life—the ability to get ideas across to others. As a group, engineers have been severely criticized for their lack of ability and interest in this direction, a criticism which is not without justification for it can be overcome by careful attention. Those who know Mr. Newman, personally or through his writings, know he possesses the ability in a high degree. Whether it is a natural or acquired character, we do not know. Probably it is a little of both for, as a Missourian with a generous proportion of native skepticism, he has no doubt experienced difficulty in gleaning the other fellow's idea from a mass of irrelevant detail and deliberately set about seeking a sure fire formula for putting his own ideas over. His formula is

Give the Answer First

By L. E. NEWMAN
General Electric Co.
Schenectady, N. Y.

THERE IS a simple technique for expressing ideas clearly which should be learned by all engineers. They, more than any other professional group, suffer from an inability to make their thoughts understood by others. It isn't that engineers don't think clearly—they do. But the sweeping indictment is made that they express what they think less clearly than does any other group having comparable education.

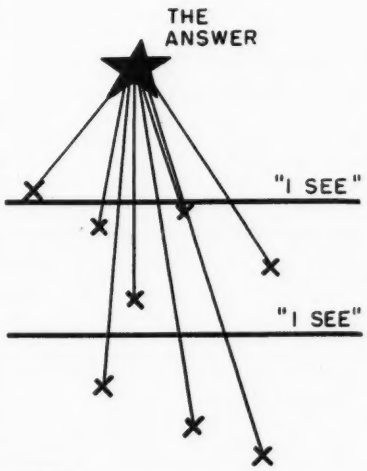
Yet this deficiency is one easily corrected. WHAT is said is important. HOW it is said is equally important, if the words are to be effective. It is the HOW that interests us here, just as it interested Dr. S. A. Moss[1] a quarter century ago when he said, "The best plan for giving instruction . . . is initial arbitrary statement of the net result, followed by . . . examples, and last of all, logical deduction of the result from previous principles."

In other words, GIVE THE ANSWER FIRST.

Opposed to this method of arranging ideas is the so-called logical deduction method by which a case is built up "stone by stone", then, as a fitting climax, the answer is given. The tough part with this procedure is that as one stone is placed upon another the listener doesn't know whether to expect a red-brick school house or perhaps an odd-size dog-house! If he knew what was being erected at the beginning, each stone as it was set in place would have a very definite purpose in his mind.

How many times does a visitor expound some idea in a way to keep you groping in the dark, until finally you say, "What the devil are you driving at?" or perhaps after listening for the better part of an hour (if you're patient and not too busy) you finally see the light and say, "Gosh, Joe, why didn't you say that first—I see what you mean now." You, in each case, have pleaded for him to give you the answer first so that you could follow what he had to say.

[1]Bulletin of the Society for the Promotion of Engineering Education. Vol. VII, No. 3, 1916. "On The Natural Method of Learning" by Sanford A. Moss, General Electric Co.



RIGHT

When you Give the Answer First like this, each successive idea may be tied to it and at any point in the discussion the listener can say "I see."

Let's examine the correct technique this way:

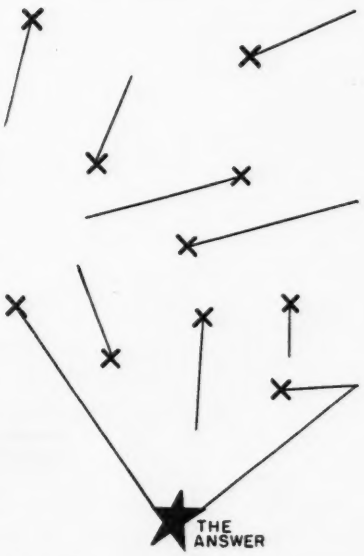
1. GIVE THE ANSWER FIRST—an arbitrary statement of fact that your listener can believe or not, but at least will understand what you are trying to prove.

2. DEMONSTRATE BY EXAMPLE — this makes the idea more tangible, and teaches your listener its application. In fact he can now use your idea even though he may not be able to prove why it works. (You know that the area of any circle is equal to πR^2, but can you prove it?)

3. PROVE BY THEORY—now your listener can learn why your idea will work. Note the "can learn". He knows what your idea is; he knows how to use it; and if he would like the information he can now learn why the idea is sound, but this is normally the least important part of what you have to say.

This technique for helping your listener understand what you have to say has a broad application. Consider the number of times you refer to the last paragraph of an article or letter to determine what the author is trying to show before you read the article. If it had been written properly you would have been given the answer first.

Bear in mind that this isn't a method of selling. It is simply a way by which you can arrange your ideas, a basic framework, which will enable your listener to understand what you have to say with the least effort and in a minimum time. It is a tool we can use to overcome our greatest weakness; that of not making our thoughts clear to others.



WRONG

When you develop your idea by logical deduction each statement made is tied to the nearest related subject in the listener's mind like this. The listener must scramble after the lost thoughts in an endeavor to tie them to the answer. Only a few are recaptured and the listener cannot say "I See" until the end.

Blow Off Tanks Are Easy

By B. H. Whitehouse
Engine-Man in Charge
Milwaukee County House of Correction
Milwaukee, Wis.

IN MANY power plants, especially in the smaller size range, boiler blowdown tanks or catch basins are treated as a necessary nuisance and receive scant attention. They are often found under the boiler room floor with inadequate covers, or, underground with poorly designed covers and vents, an ever present source of accident, noise and leakage.

To obviate all this, I designed the economically simple and effective catch basin shown by the drawing to serve three 410-hp. boilers at the Milwaukee County House of Correction power plant. It has been in service over 2 yr. with no attention and, unless informed, a person may be in close proximity to the equipment and never know that a boiler is being blown down. It is 4 by 4 ft. square, 6 ft. high, has a cover for inspection and the walls, top and bottom are of 8 in. reinforced concrete. Dimensions for a given case will depend upon the amount and frequency of blowdown but it should be noted that a square shape is more practical than a round one because the water sheet is more effective.

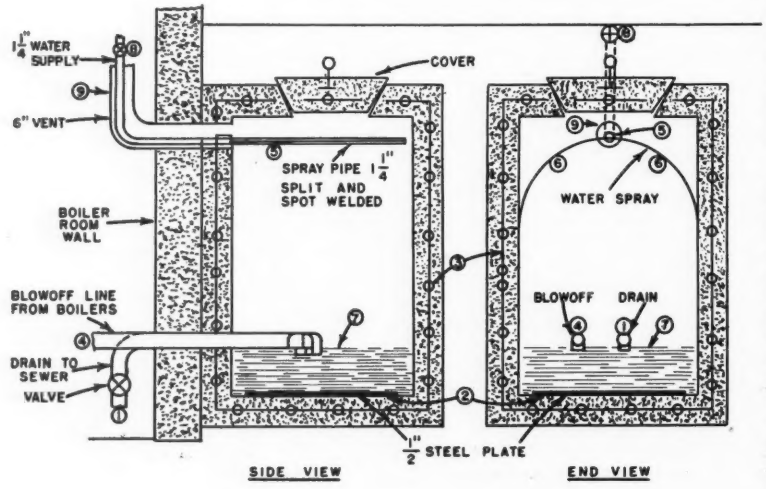
On the sketch, No. 1 is a 4 in. drain to the sewer, and may have a valve if the sewer is too small to dispose of the full flow without trouble. No. 2 is a ½ in. steel plate placed in the bottom to prevent erosion of the concrete. No. 4 is a 4 in. blow down pipe from the boilers and No. 5 is a 1¼ in. split pipe nozzle to form water sheet. Reinforcing rods are indicated by No. 3.

This pipe is made by splitting a piece of pipe with a fine saw cut, then placing the two halves together and spotwelding at 6 in. intervals on both sides, with the end welded shut. This makes a very small opening along the sides of the pipe and the water pressure forces the water in the form of a sheet into the basin to catch and condense the flash.

Number 6 is the water sheet when the catch basin is in operation. No. 7 is the water level when the basin is idle. No. 8 is the cold water supply valve. No. 9 is a 6 in. vent pipe through which the connection is made to the split pipe water sheet nozzle as shown.

To operate the catch basin first turn on the cold water supply, thus forming the water sheet. Next blow down the boiler. Boiler water enters to the approximate center of the catch basin and discharges downward through the elbow on the end of pipe No. 4. This hot water mixes with the water retained in the catch basin, thereby cooling it to a certain extent.

After the boiler blow off valves are closed, shut off the cold water supply valve. The blow down water will drain to the sewer down to the level of the drain pipe No. 1 and the catch basin will be ready for the next operation. The water remaining in the bottom cools and acts both as a cushion and heat absorber for the hot water from the next blow down. If desired the valve in the drain line may be kept closed until the water cools somewhat before it is emptied to the sewer.

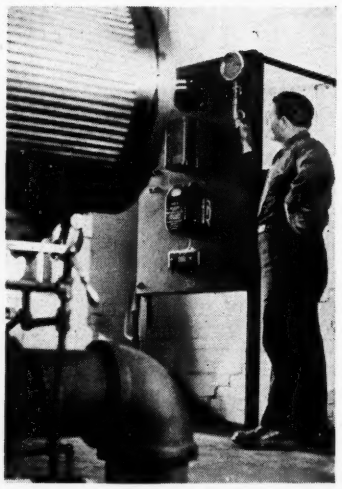


Engine Control Helps Heat Balance

By L. M. Duryee
Industrial Power Engineer
The Connecticut Light & Power Co.
Waterbury, Conn.

UNTIL RECENTLY the Gilbert Clock Co., Winsted, Conn., ran their 30 yr. old 125 hp. steam engine the year 'round to supply that portion of the plant still powered with d.c. motors. Three phase purchased power furnished approximately 250 hp. of the balance of the load, the remainder coming from a 50 hp. water wheel installation belted to shafting.

Two years ago W. F. Taylor, factory superintendent, paralleled his remaining d.c. motors in the factory with duplicate a.c. motors, to take full advantage of the economy or purchased power, in summer, when no building heating steam was required. This shutting down of the engine in summer resulted in substantial reductions in total



light, heat and power costs. All power in excess of hydro was purchased in non-heating months and the engine ran only in winter, when a heat balance could be taken advantage of.

It was quite apparent, however, that throughout the fall and spring, and even occasionally in December, January and February, there were many days when heating requirements were far less than normal and therefore a more effective heat balance seemed desirable to eliminate the waste of engine exhaust. Therefore an induction engine-generator and controls were installed last fall.

The control panel photograph shows the reverse power relay installed to prevent the generator from motoring. The speed of the new a.c. engine-generator was arranged for synchronous speed of 1800 r.p.m. The d.c. motors in the shop were permanently replaced with the a.c. motors that had been already installed for summer use and the d.c. motors were sold.

When the building-heating period arrives in October, the engine-generator is started, but steam to the engine is controlled to just the exact point of flow where all of the exhaust is utilized in the heating system. The operator merely turns the main steam valve to the point where exhaust steam begins to appear in the outside exhaust pipe. Back pressure control valves would accomplish the same, but the engineer inspects the engine hourly anyway, so the manual operation is satisfactory.

Exciting current for the induction generator is supplied by the incoming 3 ph. power, and the energy generated by the engine-generator is manufactured at the lowest steam cost possible because the actual plant load carried by the engine, and the steam fed to the engine-generator, are now not at all dependent on each other. If the indicated point of economical steam-engine power drops too close to zero by reason of high outside temperature, the reverse power relay drops the generator off the line at about 2 kw. of generated power. Wide hourly variations of generated power readings in kilowatts

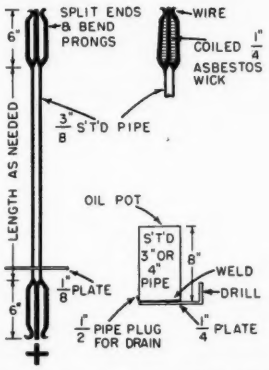
occur throughout the day in the months of October, November, March and April, due to the fluctuations in required building heating steam which the engine exhaust supplies. Not a pound of exhaust steam is wasted with this arrangement because power steam is utilized only to the exact extent that it can furnish actual by-product power.

The installation, in use for several months now, has proven entirely satisfactory. The engine governor maintains excellent speed control, so that synchronous generator speed is always assured. This practically automatic heat-balance produces the lowest total cost for light, heat and power.

Lighting Off Torch

By J. C. De Foe

LET'S PREPARE to light the furnace. How many times have you cussed because you could not find a torch and when you did there wasn't any oil around. Let's fix it so the torch and oil will be married permanently. Split a piece of pipe as shown and bend the prongs as shown.



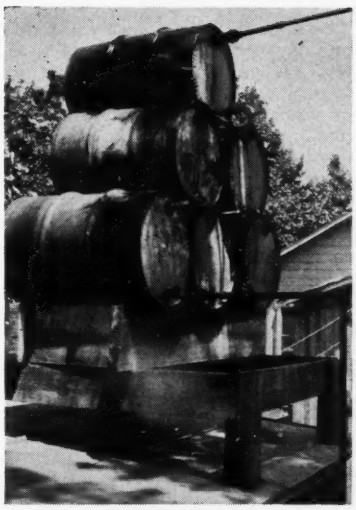
To charge the torch: Wind two layers (8 in. long) of ¼ in. asbestos wick on a $\frac{3}{16}$ in. welding rod, slip in prongs, pull out the welding rod and wire the prongs together. Keep both ends of torch charged at all times. A ⅛ in. plate cut 1 in. larger than the pot and drilled so it will slide freely on the ⅜ in. pipe will act as a cover for the pot and will protect the hand in case of a flash-back.

Drum Water Storage

By Charles C. Lynde

OIL DRUMS are frequently seen, welded together to form storage tanks for make-up water on isolated power plants with closed cooling system for their internal combustion engines. Such systems are dependent upon full water lines for satisfactory operation, and any failure of the storage tank affects the entire plant. Tanks built up of welded drums are subject to failure around the weld, especially if the make-up water be aerated or chemically active. For replacement, an entire tank must be used to replace the comparatively small area of failure, and repairs must be made with a force of men, instead of being manageable by only the attendant at the power plant.

Surmounting all these difficulties, one engineer for an isolated plant maintained



by the Sun Oil Co. constructed a 300-gal. storage tank from six oil drums, tying all together with a system of pipe connections arranged with swings so that any shifting of the oil-drum pyramid would not impose strain on any drum ends. With such a storage tank, any drum eventually developing leaks could be replaced simply by releasing the two pipe unions tying it to adjacent units, and the entire changeover made by one man.

Self-Contained Boiler Water Conditioner

WHILE RECIRCULATION of alkaline boiler water to correct feedwater conditions is not uncommon, a unique arrangement was used at the Escanaba (Mich.) Paper Co. plant to assist in controlling the sulphate-carbonate ratio in a high pressure boiler using Zeolite treated makeup. This was worked out by A. H. Wadewitz, chief engineer, and W. I. Barrows of Dayton, O., consulting engineer, when a new 400 lb. boiler and turbine were added to the plant to supplement the older 175 lb. equipment.

Alkaline boiler water was taken from a point about 9 in. below the water line near the front of the drum where the concentration is highest. This water under full boiler pressure operated a regular all bronze fitted 4 by 2½ by 4 in. horizontal duplex steam pump, and the exhaust was discharged to a large cast iron tank. Here sulphuric acid was added and the sulphate sludge formed by the reaction pumped back to the boiler as shown by the sketch.

The tank, about 5 by 5 ft. square and 6 ft. deep was sufficiently large so that if the small sulphuric acid bottle had been accidently broken, it would have been entirely neutralized by the tank contents so no acid could reach the boiler. The pump speed, and consequently the feed to the boiler, was controlled by means of the throttle valve in accordance with check tests of the boiler water. Sulphate-carbonate ratios as high as 7 to 1 could be obtained although the ratio is not maintained that high.

In addition to taking care of the high pressure boiler a dose of sludge was pumped to each of the four low pressure boilers each week. For simplicity this was fed through the blowoff line which was, on each boiler, tapped just ahead of the cock and a small sludge line run from the pump to take care of all four.

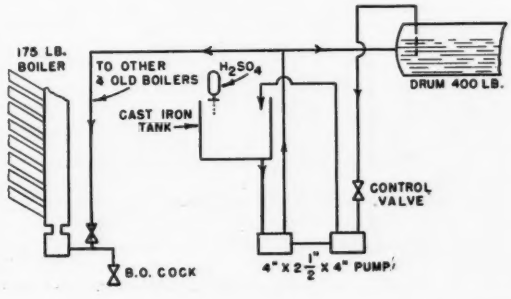
Mr. Wadewitz's comments on the operation and performance follow:

We found that accurate control was easily maintained but after about 6 mo. operation discovered that we were getting excessive ring wear in the cylinders of the American-Ball engines driving the paper machines. We first blamed the cylinder oil we were using and changed oil, but this did not correct the trouble. Ring wear would occur in a very erratic manner, as sometimes a new set of rings would wear out completely in a week's time while for periods they would last for 2 or 3 mo.

We finally connected the excessive ring wear to the periods when we had held the boiler water ratio to 3-1 or higher. Tests made on the condensate showed only a trace of Na_2SO_4, which hardly seemed sufficient to cause any trouble of that kind. We had had Dr. Straub test several actual samples of our boiler water containing various sulphate carbonate ratios during this period, and his tests seemed to indicate that our water was non-embrittling even at a 1-1 ratio, so we discontinued the sulphuric acid treatment, and almost immediately our ring wear trouble in the reciprocating engines disappeared.

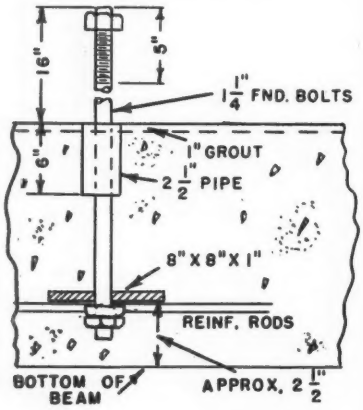
Some corrosion trouble may be experienced from CO_2 unless the sludge is discharged to the deaerating heater, as we found considerable pitting in the first four rows of our economizer tubes after about 12 mo. operation, and we believe this was caused by feeding the sludge directly in the feed pump suction line. We discharged it into the heater thereafter, but as we only used sulphuric acid for about 6 mo. after putting the sludge into the heater, we hardly are in a position to say whether that would have solved the pitting problem. The last two inspections of the economizer tubes indicate that the cause for the pitting has been eliminated.

A. H. WADEWITZ.
Chief Engineer,
Escanaba Paper Co.,
Escanaba, Mich.



Foundation Bolts

MANY DIFFERENT methods of installing or anchoring foundation bolts are used, the three major requirements being: the proper location; adequate anchoring; and a slight flexibility of the top of the bolt to allow some movement to meet field adjustments. The attached drawing shows the arrangement used successfully by one company for bolts on a reinforced concrete turbine foundation. Anchoring is provided by means of a large washer resting on top of the reinforcing rods and embedded in the beam T.



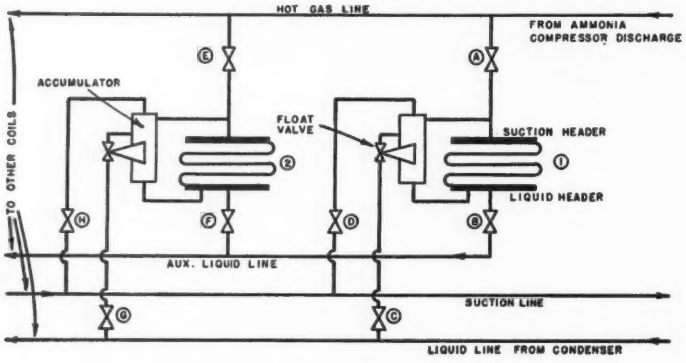
Flexibility or movement of the top part of the bolt is provided by a pipe sleeve at the top. The length of the sleeve is not critical and some engineers extend the sleeve down to the washer, a method somewhat simpler to use when the bolts are suspended from a wooden template as the foundation is being poured. The dimensions shown are for 1¼ in bolts. For other sizes the dimensions can be changed as required to give a reasonable clearance between the bolts and sleeve.

Defrosting Coils With Hot Gas

By S. H. Coleman

DESIGN CHARACTERISTICS of the individual refrigeration installation dictate the method that must be used to defrost expansion coils with hot gas. In our plant we have quite a number of these coils equipped with accumulators and float expansion valves. Our hot gas defrosting system is so arranged that ice can be removed from individual coils quickly and without undue loss of refrigeration. What is more important, defrosting process does not materially disturb operation of other coils in the system. This is accomplished by defrosting each coil separately, using it as a condenser for the hot gas and evaporating the resulting liquid in an adjacent coil.

As shown in the diagram, hot gas taken from the compressor discharge is piped to a valve on each suction header. Liquid headers are tied together with an auxiliary liquid line having a valve suitable for throttling at each coil connection. Suppose it is desired to defrost coil No. 1 using coil No. 2 as an evaporator. To do this, valves G and C are closed and most of the liquid in the two coils is allowed to evaporate. Valve D is next closed and valves A and F opened. Valve B is cracked so that it acts as an expansion valve, thus leaving No. 2 coil an evaporator. After No. 1 coil is completely defrosted No. 2 coil can be de-iced by closing valves A and H and opening valves D and E. When this is done, valve B must be opened wide and valve F cracked.



Arrangement for defrosting coils with hot gas

Handy Grip for Rope

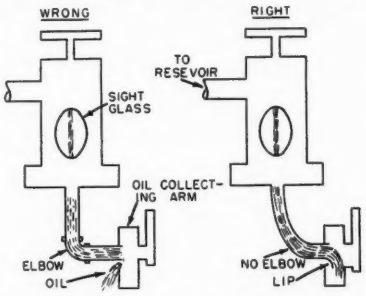
By Frank Bentley

SMALL ROPE commonly used for adjusting ventilators, traps and operating many devices about the plant is often put up without a convenient grip or handle for the drop or loose end. Wooden ones are often hard to grip with gloves or mittens on, and in many places metal grips on the free ends are out of the question. Use several pieces of common rubberized insulating tape on the end of the small rope as shown above. At suitable distances apart wind on the tape, drawing it up to the rope and the coil as it sticks on and adheres in place. Put on as many as necessary. They will not pull off or loose in spite of rough usage. No danger to anything they may contact and hit in swinging around. A good grip for the bare fingers or with any kind of a glove or mitten protecting them.

Bearing Lubrication

By Mathew Powlowski

MANY A BEARING has burned out because too much reliance has been put into sight feed glasses. The average engineer or oiler feels that so long as he sees oil flowing through the glass there is nothing to worry about. Where the drop is direct from sight glass to bearing, this is pretty well on the safe side, but, in a case where the oil is piped after leaving sight glass there is apt to be bearing failure from pipe clogging or fittings springing a leak. One of the most deceiving places on an engine is the crankpin. As a rule the crank is protectively covered. The engineer (or whoever is in charge) looks into the sight glass and sees plenty of oil flowing and is led to believe that the crank is absorbing it all.



Here is what may happen, however. Inside the case there is a pipe leaving the sight glass, bent at a 90 deg. angle and leading into the oil collecting arm on the crank. Now then, in the morning when the engine is being warmed up, the oil is also cool and has a greater adhering power. Instead of flowing into the oil collecting arm thence to the bearing, it has a tendency to "crawl" back on the bottom of this pipe and into the crank pit. Result: A burned out bearing.

In order to overcome this dangerous condition, I advise putting a "lip" on the end of this pipe as shown in the drawing.

Too much cannot be said about bearings with oil collecting rings. In the winter time these bearings will give most trouble. The oil gets quite cold during shut down and naturally offers a greater resistance on the rings with the result that the rings won't turn and trouble pops up. Be sure to put in a lighter grade of oil in bearings exposed to the cold.

Questions And Answers

Help! What's a Cuddle Valve?

RECENTLY in an examination I was asked what a cuddle valve is and what is it used for, but this term is new to me. Can you tell me what it is?

Detroit, Mich. W. F.

Friendly and appealing as the term is, we must hang our head in shame and admit our abysmal ignorance. Reference to books and catalogs showed a score or more of different valves but not a single cuddle valve. Appeal was made to Edmund Burke, then with the Crane Co., now heading his own engineering sales organization. He researched from the Atlantic to the Pacific and produced a very plausible answer. How would you like to "cuddle" the Mauretania up to the dock without benefit of tugs? The Detroit examiners must be tough—something like a Johnson bar is just too easy.

* * *

SEARCH was made of all the engineering societies that might possibly have a record pertaining to cuddle valves, the Steamboat Inspection Department at Washington and local offices up and down the Mississippi River, and the Marine Engineers Association, according to best records and evidence that could be obtained the term "cuddle valve" comes from the early river steamboat practice, as well as coastwise vessels and lake steamers, where the operating engineer had a starting bar, it was used to land and start from landing and was known as a "cuddle bar."

This bar was used in the valve gear to operate the engine under control of the engineer in making landings and departing from landings before the mechanical connections of the valve gear were set in synchronous motion with the eccentric.

There is no doubt that the small steam line used to operate the vessels so that easy control could be had of the engines, and small starting valve, was given the same number as the cuddle bar. Probably with the publication of this information in the paper you may get a few responses from some of the old time marine engineers who remember sufficient history in regard to this term of cuddle valve that they could enlighten us further on this subject. After a careful survey of something over a year the writer has not been able to get any better definition or description of this type of valve than given above.

Chicago, Ill. EDMUND BURKE.

Keeping Posted

EDITOR'S NOTE: *On page 94 of the January issue R.L.J. asked how to keep employes posted on company affairs or what Mr. Casey prefers to call "Employe Information Programs." Mr. Casey is a condenser operator in a well known central station and in 1928 was awarded the B. C. Forbes prize for his paper on Public Relations in the Electric Light and Power Industry.*

His survey of reading habits of company magazines or house organs is unusually interesting, perhaps more so to us as editors than to the general public. It is our opinion, based on many years of travel and not on definite statistics, that industrial company employes are better informed about company activities and details of their plant outside their immediate jurisdiction than are utility company employes. The influence of a well edited wide awake house organ can usually be detected by a few casual questions.

A large number of replies were received to this question. "——it's up to the Management" on page 70 and "Keeping Posted" on page 77 of the March issue have already been published. Others will be published later.

FAIR WAGES, safe, clean working conditions and reasonable job security are stones in the foundation af amiable employe relations. Supplying information to employes on company policy, structure and new developments are also necessary to the inducement of that elusive state, or condition, described as mutual management-employe confidence. Since the employe's reasoning processes depends to a great extent on his knowledge of facts, it is very much to management's interest to supply correct information to guide employe opinion into channels of clear thinking. In this way alone can the results of emotional and incorrect employe reaction be avoided.

Two years ago the writer conducted a poll, questioning a number of employes of two companies. The information gathered provided the basis for an article on public relations, (Edison Electric Institute Bulletin for July, 1938) from which I quote relative to two questions dealing with employe opinions on information.

"About seventy per cent of the employes of both companies thought that they were not well enough informed about proposed changes in policies affecting them. Most of the men thought that they should be notified in advance and reasons given so they might fully understand proposed changes. It is easy to see that considerable resentment among employes could be forestalled by the presentation of facts behind such changes.

"About half the employes taking part in the poll thought they were a part of their company, the other half feeling that they were just 'another employe.' Here again is indicated a lack of something that costs nothing and pays big dividends. Cooperation and a genuine effort to keep employes informed of company policy. Training of foremen and supervisors in the proper handling of men—not only to get results in work accomplished but to avoid antagonizing employes and creating misunderstandings. Training alone is not enough, the company should follow up and see that the foremen adhere to the methods learned.

"Fully seventy-five per cent of the employes questioned felt that they did not know enough about the general affairs of the company to discuss them intelligently with non-employes. That is a sad state of affairs! These men who have the best reason in the world for wanting to spread Goodwill for their companies are not well enough informed to do so."

The need for management to take the employes into confidence is greater now than ever, to aid in building favorable employe relations so that employes may materially assist business and industry in the mutual task of regaining and holding the confidence of the public. The suggestions that follow are not offered as a complete "employe information" program for any one company to adopt, but are rather a discussion of methods that have proven effective, any one or several of which might be fitted into any company's attempt along this line. In the small company a close personal relationship exists, fostering a general knowledge of company affairs which make elaborate steps unnecessary.

Primarily any attempt to keep employes posted must be broad enough in scope to meet the varying requirements of different groups of employes. The size of the group, the labor turnover, the wage level and other factors will determine just what items of operation the employes are interested in. In general all employes are interested in company finances—taxes, income and expenses. They are also interested in their fellow employes, in the relationship of individual jobs to the company as a whole, in how to do their own jobs better and in new developments in operation and equipment in their own and related companies.

The company or employe publication affords an excellent medium for bringing this information to the employes. This means can be used to gradually give the employes a true picture of the factors that affect the operation of their company. As an indication of employe interest in company publications I present the following results of surveys conducted among the readers of two

different company's magazines. Company A's survey was early in 1939 and company B's early in 1940. All values are in per cent.

How Thoroughly Read?	Company "A"	Company "B"
Cover to cover	65.8	65.5
Special articles only	18.8	26.0
Skim through	10.4	8.1
Not at all	....	.006
What Features Are Enjoyed Most?		
Pictures	86.7	....
Employe activities	81.3	54.2
Departmental Personals	70.9	64.3
Technical Articles	50.4	47.0
Trends of Business	....	51.8

The figures offer conclusive proof that the employe publication, if atttractive in layout, well illustrated and well written, is a valuable medium for imparting information. The fact that most employes take their copy home for the family to read adds to its value.

Special bulletins on the plant bulletin boards may be utilized to emphasize certain points. Folders may be prepared and distributed, or enclosed with the paycheck. Calendars, designed to tell a story as the monthly pages are removed have proven an effective means of giving information, especially so when they are distributed for the employes to use in their homes.

Some companies have found it advisable to issue an annual or semi-annual report to the employes similar to that issued to the stockholders. Such a report should be written in a manner understandable to the employes, attractive in format and should contain such items as gross income broken down to broad sources, operating expenses, also in broad items such as materials, salaries, wages, taxes, net income, dividends, interest, etc.

Departmental and inter-departmental meetings should be held as a means of acquainting employes with the problems of their fellow workers and of the company. Such meetings are undoubtedly valuable aids in increasing efficiency and morale of employe groups.

In connection with any employe information program the foreman or supervisor deserves special consideration. In daily contact with the employes the foreman is not only management's representative to the worker, he must also be the worker's representative to the management. Consequently he must, if he is to fulfill his responsibility to both, understand his company's aims and policies and be in a position to intelligently answer the questions of the employes. The training of foremen in modern methods of leadership is as important today as training him in the supervision of the operations of his department.

Courses of instruction in company processes given by department heads increase the general knowledge of the employes and make possible promotions from among the employes. It is also advisable for the company to pay part or all of the cost of outside instruction facilities when employes wish to fit themselves for better jobs.

Industry is gradually learning that labor strife, mistrust and suspicion breed rapidly where employes are uninformed.

Springdale, Pa. Edward A. Casey

Measuring the Volume of Liquids in Horizontal Tanks

On page 740 of the November, 1939, issue of your esteemed magazine you presented a method for determining the contents of cylindrical horizontal tanks with flat heads. While the method shown is effective you may be interested in another method which is outlined in the following paragraphs.

The following simple formula gives the volume of liquid or other free flowing material in a horizontal tank with flat heads and when filling only the lower half of the tank, that is, from f = o to f = r.

$$V = L\,W = L \times \frac{4}{3} f^2 \sqrt{\frac{2r}{f} - 0.608} \quad \ldots (1)$$

where V = the volume of the material in cubic feet
L = the length of the tank in feet
f = the height of the segment (see Fig. 1)
W = the area of the segment
r = the radius of the tank.

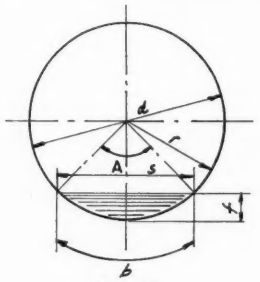
This formula should be considered as rather approximate; at the same time, however, it is precise enough to permit its general use in practice.

To show how little the results obtained by the use of this formula differ from those given by the precise formula for determining the area of the segment of a circle, I have worked out a problem first by the use of the precise formula and then by the use of the simple formula given above.

The precise formula for the area of the circular segment is as follows:

$$W = \frac{r^2}{2}\left(\frac{A\,\pi}{180} - \sin A\right) = \frac{r\,(b-s) + sf}{2} \quad \ldots (2)$$

where A = the central angle in degrees (see Fig. 1)
b = the length of the arc corresponding to this angle
s = the length of the chord.
f = the height of the segment
$A = \frac{A\,\pi}{180}$ = the angle subtended by an arc equal to the radius



(Fig. 1).

Let us take the height of the segment $f = \frac{r}{2}$. The angle A when f = r/2 is equal to 120 deg.

The precise formula will give the area of the segment as follows:

$$W = \frac{120}{180} \times \frac{\pi}{2} r^2 - \frac{r^2}{2} \sqrt{\frac{3}{4}} = 0.6142\, r^2$$

The approximate formula gives

$$W = \frac{4}{3} f^2 \sqrt{\frac{2r}{f} - .608} = 0.614\, r^2$$

Thus, it will be seen that the difference in the result obtained by the use of these formulas is only 0.0002 r^2.

This formula as mentioned before gives the volume when filling the lower half of the tank. When the upper half is to be filled the volume of the liquid is determined by the following formula:

$$W = L\left[\pi r^2 - \frac{4}{3} f^2 \sqrt{\frac{2r}{f} - 0.608}\right]. \quad (3)$$

If we have f = o, then $V = L\,\pi\,r^2$
f = r, then $V = 1.57\,L\,r^2$
f = r/2, then $V = 2.527\,L\,r^2$

A COMMUNICATION FROM FINLAND

It is not often that the rumblings of Europe's conflict reach these pages but recently we received a letter from a reader in Finland which in a simple request furnished eloquent testimony to the hardship and human suffering which war imposes on its victims. Mr. Gauljaeff, who writes the letter, is an engineer in Helsingfors and as a result of his interest in the tank level chart which we published in the November issue he sends us an article presenting another simple but accurate formula for determining the water level in horizontal tank. This article is presented in these pages but we felt that his letter would add to the interest of the article and so we present it as follows.

Helsingfors, Feb. 15, 1940

Dear Sir:

I am taking the liberty of sending you the article "Measuring the Volume in Horizontal Tanks" and ask that you be so kind as to post the payment for it to my 76 yr. old mother-in-law, Mrs. Elena Hosiainoff, who is now living in Sweden with my little daughter. Their address is Stockholm, Tegnergatan 12 hos Fr. Edit Nilsson.

They both are evacuated from here in consequence of the war and I may help them only by such way, as the sale of foreign currency is prohibited in Finland.

The father of my mother-in-law, Mr. Imgal, was an Englishman and I hope you will be so kind as to help them by publishing my article.

Yours faithfully,
N. Gauljaeff.

On the basis of these formulas a table can be compiled which enables us to find the volume of the liquid in terms of a unit of length.

(Editor's Note—The author calculated such a table and enclosed it with his manuscript, but since it occupies some 8 pages we cannot reproduce it here. Such a table, however, is presented on page 77 of the Tenth Edition of Kent's Mechanical Engineers Handbook. It also appears on page 17-43 of the Eleventh Edition. This table gives a coefficient in terms of the ratio f/d.)

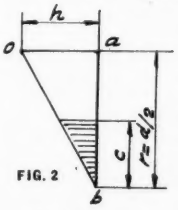
If we know the diameter of the tank and if we take the square of it and then multiplying this square (d^2) by the coefficient obtained from the table we will obtain the area.

Example (1): Let us have $d = 44$ inches and $f = 16$. Then $\frac{f}{d} = \frac{16}{44} =$ 0.364. From the table we receive coefficient 0.258395. The area of segment is equal: $44^2 \times 0.258395 = 1936 \times 0.258395$ $= 500.25272$ square inches, or $\frac{500}{144} =$ 3.47 square feet.

Example (2): If d is 44 inches and $f = 30$ inches, the area would be $\frac{\pi d^2}{4} - 44^2 \times 0.214802 = 1{,}520.530000 -$ $415.856672 = 1{,}104.673328$. The area 415.856672 is the area of the supplement segment $44 - 30 = 14$ in. $\frac{14}{44} = 318$ and suitable coefficient would be 0.214802.

The area of the segment is then:

$44^2 \times 0.214802 = 415.856672$



In case of determinating *the volume of a tank with spherical heads* the problem is more difficult because we shall have an additional volume, on account of the spherical head.

The long and tiresome calculations may be avoided by adopting a simple way, which within the limits of error, admitted in the calculations, gives good results.

At first we have to determinate the volume of the spherical segment formed by its head according to the height of the segment and the diameter of the tank.

Formula: $V = \frac{\pi f}{6} [3 r^2 + f^2]$

where f = height of the segment
r = radius of the tank.

Thereupon we have to consider the head as a cone (Fig. 2) and the triangle oab is corresponding to the half of the volume of the spherical segment. If the height of the segment is f = oa and the radius of foundation of the segment is ab = r, then

$$V_1 : \frac{V}{2} = C : r$$

where C is the height of the level of the product.

The results attained by this method naturally are rather approximative, but they are quite sufficient for measuring experiments.

When calculating the precise volume of large tanks, we have to fill them with water and measure the height of the segment.

For this purpose one uses a rubber hose and connects it with the lowest point of the tank. The other end of the hose is to be connected to a glass-gage which has a board with divisions in inches. To the upper manhole of the tank should be lead a hose from the small measuring tank, the capacity of which is about 5 cubic feet.

This tank is to be placed approximately at the height of the manhole or higher. One fills it up to a known volume, and by opening the lower stop cock of the tank, one lowers the water down in the tank, which we have to measure. After the level of the water has settled, one inscribes the water-level attained in the glass-gage.

By repeating this process until the tank is completely filled the gage will show how the volume varies with the water level.

The results should be platted on a piece of paper in form of a curve which makes it possible to calculate the quantity of the liquid accurately.

Alarm Circuits

FOLLOWING is the third installment of the replies to C.E.'s question on page 81 of the February issue. Other circuits appeared on page 78 of the April and page 82 of the May issues.

Quite the simplest arrangement is offered by W. A. Mueller, Decatur, Ill., by means of a simple 6 v. bell connected in series with the lamp as shown in Fig. 9. With this Mr. Mueller uses

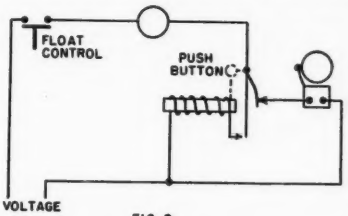
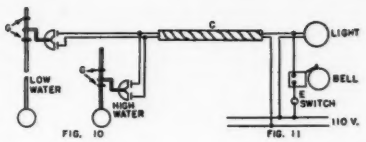


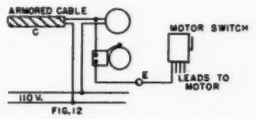
FIG. 9

what amounts to a single pole double throw switch, which is manually thrown in place of using a push button. Once thrown the bell is cut out but the lamp is lit and the armature held in place as long as the float contacts stay closed. An old bell with the connections changed slightly should serve well for this purpose. By adding a push button as shown dotted remote cutout of the bell could be accomplished.

While not answering C.E. directly, Mr. Bradley gives some good advice about automatic pump control and alarm systems. His letter follows:

"We installed a high and low water alarm and control system in our supply tank but we use a horn instead of





a bell and the manual switch cuts off both light and horn. As we would get into serious trouble if the supply tank should get too low we also have a low water alarm. We use 110 v. with no secondary circuit as that would be more expensive to install and in a 6 v. system with a battery there would be much more maintenance.

"The switches used in Fig. 10 are Mercoid's operated by an arm and were purchased for less than $4 apiece. The wiring is armored cable with two No. 14 wires. In Fig. 1 is shown the assembly of low water switches which should be located above the tank high level so as to allow the floats to go down into the water freely.

"In Fig. 10, C is the carrier circuit going to C in the bell and light circuit Fig. 11 which may be located where most convenient. Figure 11 shows how to wire the light so it will be on till the operating switch above tank reverses. E of this figure shows the manually operated switch on the return wire to cut out the alarm. If desired this may be arranged to be operated when the motor is on as in Fig. 12. Wired as in Fig. 12 the bell will not ring until the float throws the operating switch on. When the motor is stopped the bell will stop ringing but the light will stay on till the switch cuts out. If a low water alarm is used and the bell wired as in Fig. 12 it will not ring when the low water alarm is on but the light would be lighted.

"If the voltage on the motor is higher than the 110 v., a transformer can and should be used on the bell circuit. With a 3 wire motor care must be taken to connect the bell wire to right connection. The floats as shown can be adjusted to any rise or fall of the water by the adjusting collars G."

LESLIE BRADLEY.

Dakota Public Service Co.
Bismarck, N. D.

Oil Difficulties in a Refrigeration Plant

THIS IS in reference to G.R.W.'s problem on a refrigerating compressor pumping oil. (p. 80, February) The only way to rid a system that has once become coated with oil is to dismantle all the pipes and blow out with 100 or 125 lb. compressed air. In cases where the oil has formed a sludge or extra heavy coating, they may have to be reamed with a wire brush.

To prevent oil, carried over from the compressor, from reaching the heat transfer surfaces, an oil separator should be installed in the discharge line, just ahead of the compressor.

Compressors always have a tendency to carry over a certain amount of oil, but if any excess amount of oil is carried over, the compressor should be overhauled. It may need new oil rings and possibly the cylinder rebored. In case the cylinder is fitted with a liner it is only necessary to replace the liner.

Baltimore, Md. C. W. PARKS

* * *

G.R.W. does not state what type of refrigerating system he has or what type of refrigerant used. With lack of proper clues it is hard to make proper recommendations but the following applies to very small unit systems.

In some cases, where this trouble is not very bad, you can get enough oil back to the compressor by simply filling the ice cube trays with boiling water and then running the machine for a time. The heat thus applied to the evaporator will make the refrigerant boil violently and the suction from the compressor will pull the oil particles down through the suction line.

Another method of returning the oil is to flood the evaporator. With a flooded system, stop the compressor and turn the low side service valve to close the opening into the crankcase. Then tilt the evaporator, so that the float valve is opened. You will hear a hissing sound from the incoming refrigerant liquid and when this sound stops the evaporator is full. Then put the evaporator back on level position.

Next start the compressor and crack the low side valve so that the pressure on the low side of the system is kept just below zero on a compound gage attached to the service valve port. Finally, open the low side valve fully and run the machine as in normal operation to see if the symptoms of too little oil have disappeared.

With a dry system where too much oil is in the receiver, you can run compressor several minutes to produce a vacuum in the evaporator. Then with compressor still running open the expansion valve. Running the compressor 2 or 3 min. will pull all the refrigerant liquid, along with any excess of oil, from the receiver through the evaporator.

Now close the expansion valve and again run the compressor to get the refrigerant out of the evaporator. You may have to repeat these operations several times to circulate the refrigerant charge around through the system and get the regular amount of oil back into the compressor.

If you are successful, the noises of insufficient oil will not change its reading. Then the receiver service valve is opened just enough to balance the pressure and leave about 1 lb. showing on the gage. The liquid line and the suction line are now disconnected from the evaporator and the ends of both these lines plugged. The evaporator can be removed from the refrigerator and the oil dumped out of it.

This oil measured will have to be replaced in system. The evaporator is replaced and the liquid and suction lines attached. Then next purge air out of evaporator and lines tested for possible leaks. If no leaks, remove gage and turn on the valves. Be sure to add oil to compressor that was removed.

To prevent oil from entering heat transfer surfaces one must determine whether the refrigerant is lighter or heavier than the oil being used in compressor. Heavier oil forms a layer on the liquid refrigerant and can be skimmed by holes in the tubing of the suction line and thus carried to the compressor.

Should lighter oil be used try to find closed or bucket type floats. The heavier liquid is carried to the bucket by high velocity. The smallest gas velocity used is not less than 1000 ft. per min. When the refrigerant is evaporated from the mixture the remaining oil is carried by the suction line to the compressor.

Still another method used is an oil separator in the evaporator. The splashing of the boiling liquid refrigerant throws the mixture of oil and refrigerant into an extension tube of copper which is located in the warmest part of the evaporator. The refrigerant is evaporated from the liquid mixture inside the copper tube and the remaining oil runs down over small recessions and by way of the suction line to the compressor.

To prevent an excessive amount of oil pumped into the refrigerating system a long or trunk piston should be used. This piston consists of two sets of rings. The set located on top prevents compressed gas from leaking past the piston while the lower set scrapes excess oil from cylinder walls, and prevents upper rings from wiping an excess amount of oil into the top of cylinder.

WILLIAM MUSIAL

Letters and Comments

An Open Letter to a Watch Engineer

DEAR TOM:

Congratulations! on your new promotion. Oh by the way, I hope it is all right for an ordinary operator to call a brand new engineer by his first name? Yeah, I know. I can just see you saying "Can it, Joe. I'm still one of the boys you know."

Well, Tom, this brings me around to what I want to say. You know, a little advice from one of the gang to another. For, after this you are supposed to give us advice.

Last week when they called you into the office, they not only gave you something; they also took something away. Yeah, I know you got a forty dollar raise and your title changed from utility operator to Watch Engineer. Yep, you're on the other side of the fence now, Tom. They took away your privilege of free speech. You are now a model instead of an ordinary. You can't say or do as you please. You are supposed to be looked up to. You are responsible for any and everything that happens on your watch. You are supposed to have the confidence of every man working under you. Also, you have the confidence the Chief placed in you when he made you an Engineer. To keep this confidence you have to support the morale of the workmen and . . . the workmen have to support you.

It's funny, Tom, me telling you this when I remember it wasn't so long ago that you were telling us over coffee one night . . . "If I were Engineer I would . . ." Well, you are Engineer now, Tom, so let's see if you will. Let's see if all the things you said, all the things you, I and the rest of the gang agreed and disagreed on are still going to look the same to you.

Yeah, we know. You mean well. You are going to do right. You are going to have the best watch in the plant. All the promotions and raises will go to your shift. Yeah. Well, remember, you can't help a man by running him down. You once told me that "licking a mule won't get him up." O.K. Tom, it's your turn to drive the team.

Remember last year after you came back from your vacation (you were one of us then) you told us about a tour you took through a big prison out west? Remember how you said that it reminded you of the plant here? How you referred to us as "inmates" and old Harry the Watch Engineer as "the guard"? I agreed with you Tom. It was like that then but Harry is gone now. You are taking his place. Let's see how you are going to run the place or the "prison" as it were. Let's see if you will make the men "inmates" or "trustees."

Tom, I know you're thinking not only of what the gang is thinking but also of what the Chief told you when he called you in the office to tell you about your new job. Swell guy, old Chief. I can see him now taking a puff off of that stinking cigar and saying in his gruff voice. "Er . . ah, Tom . . . been intending to have a talk with you . . . It's about . . ." Yeah, we know Chief, we are away ahead of you but will sit and listen cause . . . well not only because we have to but because we like to.

The Chief will tell us that there is no place like a power plant. That there is a great opportunity. He'll tell us if our work is good or bad. But remember, Tom. You and the rest of the Watch Engineers are his reference. You can go in and sit down whenever you care to. You can tell him about changes in operation, about buying this or that piece of equipment, then, after awhile the subject reverts to the men.

"How is Jack doing in the Boiler

WORRY about boiler feedwater trouble won't spoil this chap's trout fishing! His mind is free from care about scale, corrosion and other worries because his plant is protected by the Nalco System of Feedwater Treatment! Nalco offers a complete water treating service. Besides protection for boilers, trouble-making scale formation can be prevented in heaters, economizers, feed lines, pumps, condensers, and other equipment that comes in contact with water. This includes Algae control. Adoption of the Nalco System requires no additional capital investment and total cost may be less than your present expenditures for chemicals alone. Write for complete information today! NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Illinois.

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Room?" the Chief asks.

Here, Tom, is the cross-roads. You can either part here and leave your rank as a trusted, loyal, dependable and respected engineer or you can take the path of "least resistance" and revert back to Harry's "prison method" and say . . .

"Chief, I been aiming to talk to you about Jack. For about the last few months he has . . . "

Has he, Tom? Are the things you are telling the Chief correct? Remember, Jack can't defend himself and he is depending on you for a break. Remember, too, the Chief is depending on you for the truth, this is when the raises and promotions are born.

Yep, Tom. "You can fool some of the people some of the time . . . " and "Harry doesn't work here any more."

Well, so long, Tom, lots of luck and I'll see you in church . . .

Respectfully,

BILL.

Problem 7 Continues

JUST COMPLETED reading various letters making suggestions as to how to remedy trouble experienced in operating of two rooms, one 40 deg., other 10 deg. (Problem No. 7 p. 82, March issue). Nothing is said in regard to the size of each room, the square foot of evaporative surface, insulation, size compressor, etc., but I assume it is as near a balanced installation as one would find. Most of contributions advise installation of thermostatic valves in the suction from each room and also in the liquid feed ahead of the hand operated expansion value to each coil.

This will not solve problem because often the valves may open to each room at, or near enough, the same time to feed liquid to each room. As a result, the high suction pressure existing from 40 deg. room would simply cause the evaporator in the 10 deg. room to fill up with liquid. Probably the compressor would run warm also, due to insufficient saturation suction gas. Then say 40 deg. room comes down in temperature to the point where the thermostatic valves in the liquid feed close and the suction line valve from this 40 deg. room also closes.

What happens? The suction pressure from the 10 deg room diminishes rapidly causing the excess liquid, which has accumulated while high suction pressure existed, from the 40 deg. room, to come over and expand in the compressor cylinder.

Taking it for granted that we may have the above condition exist often, with both the 10 and 40 deg. rooms "on line" as we engineers interpret it, then we must place a pressure operated liquid expansion valve in 10 deg. room. Why? So that in the event that both rooms come "on line," the evaporator in 10 deg. room will not get liquid until the 40 deg. room is off the line and the suction pressure in the 10 deg. room has been reduced to the pressure for which it is set.

I would make it a full automatic plant, either room starting the compressor and opening the thermostatic valves in each room independent of each other. If necessary install an independent booster liquid expansion valve to each room to open only in case the suction pressure gets too low because the room is off line, but in most cases this will not be necessary. The writer has installed one plant with 15, 32, 43 and 52 deg. all on one suction line, arranged so the second compressor only cut in when the suction pressure exceeded a given valve.

Los Angeles, Calif. WM. STUBBE.

The Other Side of the Hotel Business

Editor's Note: While the author has had a number of years' operating experience in smaller industrial and commercial plants, he is now employed in the Results Department of a modern middle western central station. Quite naturally he presents the case for purchased power in the hotel. The article was written before the appearance of Mr. Douglas' hotel articles (page 50 of the February and page 41 of the March issues) which built up a good case for private generation of power. Mr. Williams' remarks must not, therefore, be construed as a comment on Mr. Douglas' articles, but rather as a complementary article presenting the other side of the picture. Even though you are not a hotel engineer do not overlook what Mr. Williams has to say about operating engineers who fail to recognize opportunity when it knocks. After this go back and study the article on p. 40 of the April issue to see how cleverly the steam and power balance was worked out in the Fox Store.

SOME PLANTS adapt themselves to the economical generation of power better than others, but if power is to be generated economically in small and medium sized plants, a use for exhaust steam is almost imperative. A hotel makes an ideal set-up in most cases as heating systems, hot water demands, both for room service and laundry, are usually large and require steam at from atmospheric to five pounds pressure so that it can be supplied by exhaust from engine driven generators. I have in mind a 1000 room hotel in a medium size city. The service requirements of this hotel for power, heat, light, refrigeration, cold and hot water is met by a plant located in the sub-basement.

It consists of three 415 hp. straight tube cross-drum boilers supplying steam at 150 lb. pressure, saturated, to: two 400 and one 600 kw. vertical engines generators operating at 3 to 5 lb. back pressure; two Corliss and one slide valve engine driven refrigerating compressors; a steam driven air compressor; and a battery of duplex pumps supplying boiler feed, house service water, cold brine, laundry water, etc. Exhaust from all of these steam driven units is used in a heating system consisting of 78,093 sq. ft. of direct and indirect radiation and to heat an enormous amount of hot water for room service and laundry purposes.

This seems at first glance to be an ideal set up for generation of power but let us look at it a little closer. During approximately 4 mo. out of the year electricity can be generated for less than 1 ct. per kw-hr. but the remainder of the year the picture is much different. During summer months, out of a total of 20,200,800 lb. per mo. of 150 lb. steam generated, 18,465,000 lb. is wasted to the atmosphere.

Generator engines have a water rate of 55 lb. per kw-hr. under these conditions. Steam at 150 lb. is being produced at 32 ct. per M lb., taking into account labor and fixed charges, so the cost of a kilowatt of current during summer months rises to over 6 ct. The average cost for the year is over 4 ct. and it becomes uneconomical to generate. As air conditioning becomes more popular, 200 hp. of electrical load was added and this being a summer load made the balance worse. Another interesting thing to note as a comparison, is some figures on the heating load during winter months when with the generators shut down, heating system, taking steam through a reducing valve, required only 85 per cent as much steam as when the generator engines are operating.

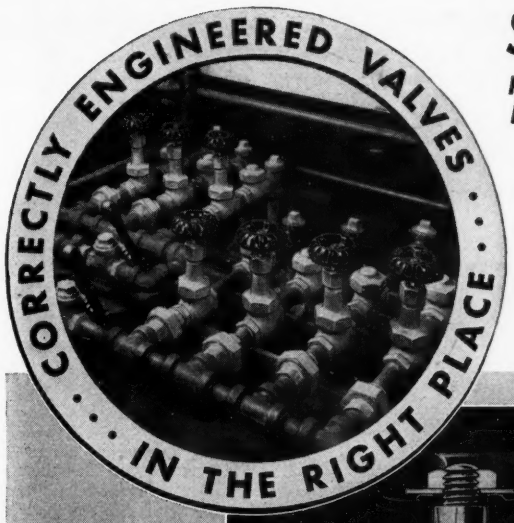
Extreme conditions are encountered in many isolated plants and should be given attention. The general attitude of the engineer seems to be that nothing can be done about such conditions but this is not true. By close comparison of actual conditions such unbalanced set-ups can be avoided. Think of many uses these huge amounts of exhaust stem can be used: the use of low pressure turbines driving refrigerating compressors in air conditioning work; the use of a combination of condensing and non-condensing generating equipment; or the Diesel in combination with steam to iron out some of the wrinkles.

Over a period of years chief engineers and operating engineers of plants have a chance to express their ideas to superiors and sell these ideas to the business heads of the companies.

If the operating man can talk the same language as the business executive, usually costs in dollars and cents, he can sell an idea that in time will pay his company dividends. Usually he sets by and watches his firm spend thousands of dollars for equipment and changes which he knows will cause him and his employer much grief. Remember I am speaking of the small and medium sized plants where the management does not hire a consulting engineer to recommend and plan changes.

If the operating men were on their toes they could probably do as good a job as the professional engineer and possibly better. But first, instead of cursing the manager and professional engineer like a jealous school boy, he must get out of the rut of playing second fiddle, study, keep up with modern engineering practice and finally learn a little salesmanship. This is just the thought of an operating engineer who has seen several small isolated generating plants shut down by purchased power.

R. R. WILLIAMS



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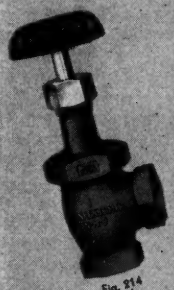
Fig. 214 Angle

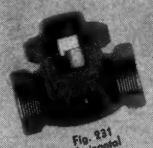
Fig. 231 Horizontal Check

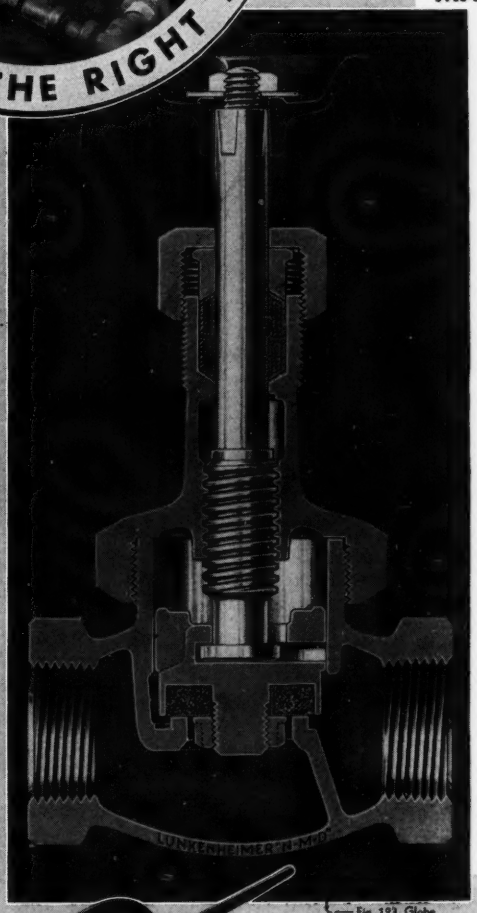
Fig. 123 Globe
150 lb. S.P.—300 lb. W.O.G.

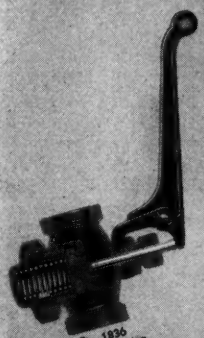
Fig. 1836 Quick Operating Pull Lever

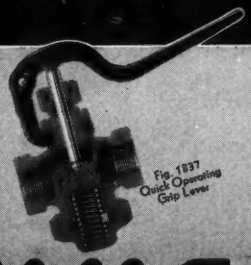
Fig. 1837 Quick Operating Grip Lever

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All of the features mentioned above are tangible evidence of the all-over superiority of Lunkenheimer products which originates with the selection of only the finest materials and is constantly assured through painstaking manufacturing and testing processes. You'll have to take our word for these latter qualities, but our distributor's salesman will gladly take a Lunkenheimer valve apart and show you exactly wherein it visibly excels any valve you may be using. Ask him for such a demonstration on his next call!

Send for copy of our new Catalog No. 78. We will include our handy "Guide", which makes selection easy by grouping valves, boiler mountings, and lubricating devices according to pressures, temperatures, and service applications.

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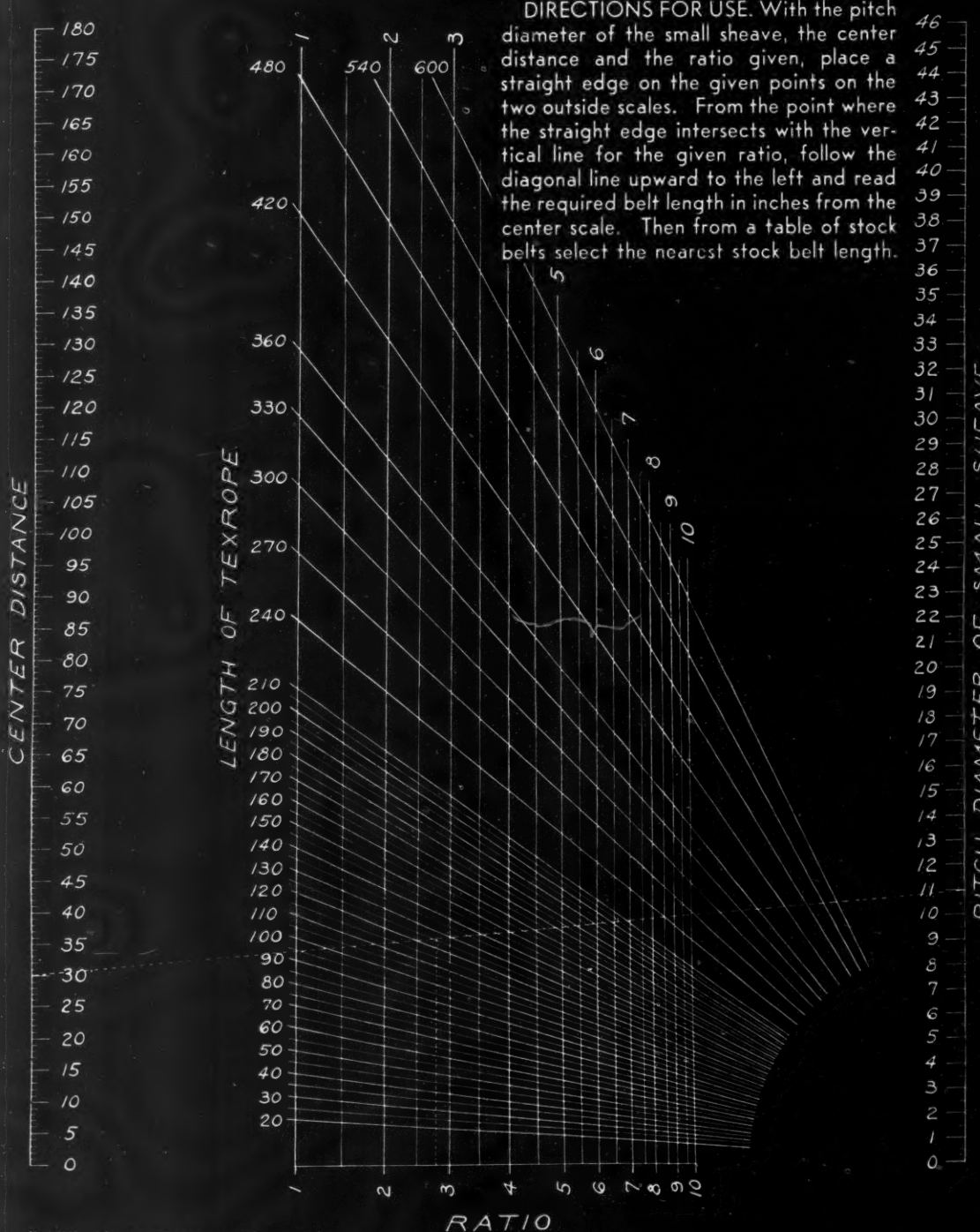
All dimensions are in inches. Note that the diagonal lines do not represent stock belt pitch lengths, but are the inches of length required.

DIRECTIONS FOR USE. With the pitch diameter of the small sheave, the center distance and the ratio given, place a straight edge on the given points on the two outside scales. From the point where the straight edge intersects with the vertical line for the given ratio, follow the diagonal line upward to the left and read the required belt length in inches from the center scale. Then from a table of stock belts select the nearest stock belt length.



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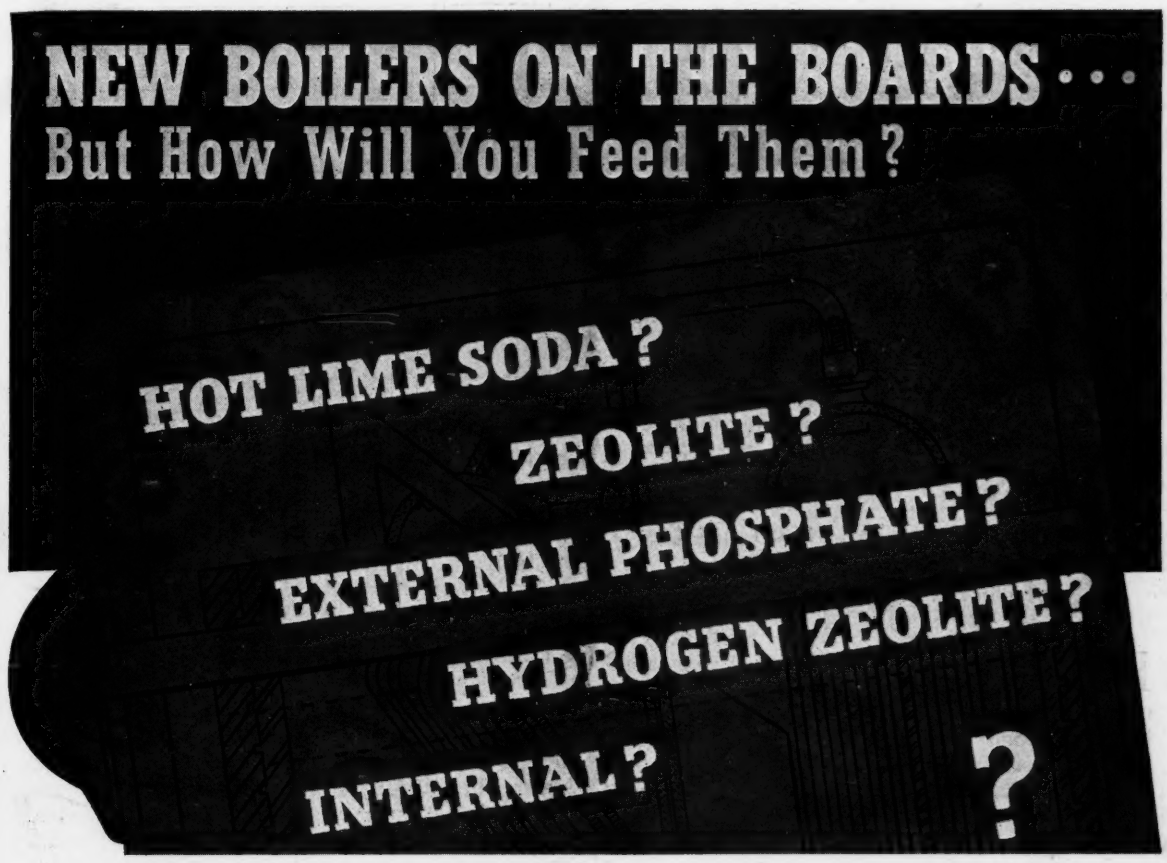

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Diesel Cranking Batteries

Electric starting of Diesels under all conditions presents a real battery problem and was made the subject of an extensive research program. As explained by the authors in an S. A. E. paper, this involved a cold room, controllable down to –30 deg. F. and arranged to simulate a 6 m.p.h. wind, with necessary instruments including oscillographs, to give the required data. The following is an abstracut of the paper with data representative of typical high speed 2 to 8 cyl. engines with displacements of from 175 to 1500 cu. in.

By L. E. LIGHTON and H. C. RIGGS
Development and Design Division
The Electric Storage Battery Co.

DIESEL ENGINES of the so-called high speed type are the hardest to start since the minimum cranking speed required for satisfactory firing has been found to be in the neighborhood of one-tenth of the rated operating speed, much higher than necessary for large, slow-speed engines usually started by the higher voltage systems or for equivalent size gasoline engines where volatile fuel is ignited by a spark. Important factors which affect starting speed are the compression ratio, the piston type and material, the method of fuel injection and the method of applying heat for low temperatur starting. It is important to give serious consideration to each in order to reduce to a minimum the required firing speed.

It is possible by prolonged cranking at a low speed to accumulate heat within the cylinder and thus eventually start the Diesel engine but this becomes a question of battery and starting motor economics when the starting time exceeds one minute. A comparison of typical tests shows this. An initial cranking speed of 70½ r.p.m. required 24 sec. for the first fire, 102 initial r.p.m. required only 8½ sec. with eight firing impulses in the following 22½ sec. before the engine would continue under its own power. During the same 22½ sec. the slower cranking produced only 5 firing impulses and a total of 10 over a period of 40 sec. was needed before it would run under its own power. The slower speed naturally requires more battery capacity but the higher requires more battery voltage.

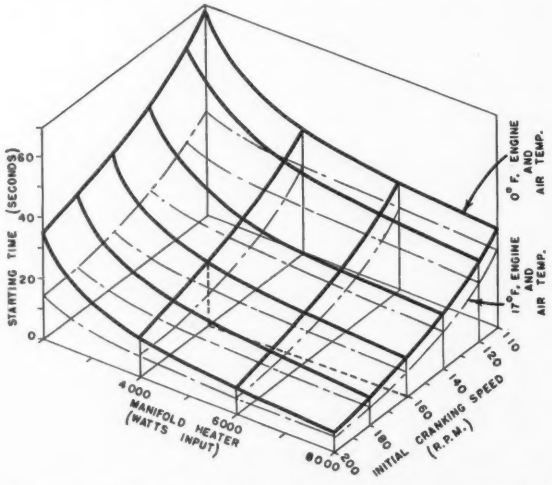


Fig. 1. Comparison of starting time showing the effect of cranking speed and manifold heat

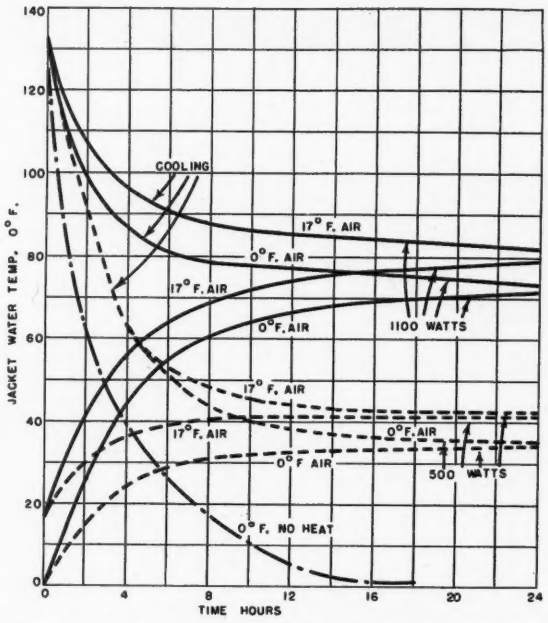


Fig. 2. Jacket water temperature as a function of hours for cooling or heating with two sizes of immersion heaters and for two different air temperatures

In both instances it was necessary to build up the cranking speed of the engine to approximately the normal idling speed before releasing the starting motor. This build-up in speed, as the result of intermittent firing which rapidly increases temperature within the cylinders, must be depended upon for most low temperature starting since the battery size required to produce such a speed and its resulting temperature would usually be prohibitive.

A more rapid temperature rise may be obtained from high cranking speed by a reduction in "blowby" insofar as this is possible through the selection of piston material and piston fit. Because of manufacturing tolerances it has been observed that the smaller engines with smaller bores and consequently higher percentage blowby invariably require the high cranking speeds to build up sufficient heat for firing.

Temperature for ignition of the fuel may also be obtained from sources other than cranking speed or compression. The heat needed may be applied by: electrical air intake heaters located in the intake manifold; glo-plugs located in the ante-combustion chamber; or flame drawn into, or applied to, the manifold. Whatever the means, the primary object is to increase the temperature of the air entering the combustion

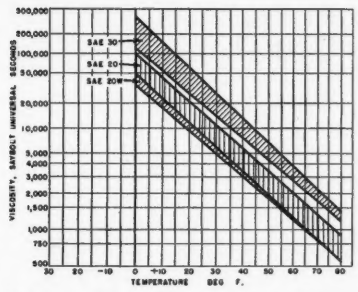


Fig. 3. Variation of average oil viscosity with temperature

chamber in order to bring it that much nearer to the required firing temperature of the fuel (which is apparently quite critical at temperatures below 25 to 30 deg. F.), and thereby leave less work to be done by the starting system. Figure 1 has been prepared to show the effect of both cranking speed and of air intake heat on the time required for starting.

Considering only the effect of heating the air, it is observed that under certain conditions for 0 deg. starting, there is little advantage in applying more than 4000 w. of air intake manifold heat regardless of the cranking speed because the curve becomes quite flat beyond 4000 w. At 0 deg. we would expect only 2000 w. to be required. Another method of providing an aid to the electric starting system to produce quick starting is the use of an immersion heater in the jacket water or lube oil sump. By maintaining higher than ambient temperatures in these parts, the oil viscosity is reduced and equivalent power applied for cranking will produce greater speed. Consequently high firing temperatures are reached in a shorter time.

Figure 2 shows first, the manner in which an engine cools down to a zero degree temperature with respect to time. It also shows the effect of applying an electrical immersion heater of either 500 or 1100 w. in the water jacket, and the effect which this has on either cooling down or warming up in both zero and 17 deg. ambient air temperatures. It will be noted that the temperature is fairly well stabilized within the engine at the end of 16 hr. This probably explains why many Diesel engine operators whose engines are stopped but a few hours are able to "get by" with batteries smaller than those which would be normally required for longer lay-over periods.

On the basis of Fig. 2 an 8 hr. stand would reduce the engine from an initial temperature of 130 to 19 deg. although in the case of a field installation where the engine would be somewhat protected from wind, we might expect more gradual cooling. From an efficiency standpoint, with the storage battery as the only source of power, it is much cheaper to provide quick starting by the use of an air intake heater than by maintaining jacket water temperature.

Even though the jacket water temperature is maintained at 100 deg. by an immersion heater, the lube oil sump will remain approximately that of the ambient air temperature. The reduced starting time affected by the use of jacket water heater is the result of the combined reduced cranking current brought about by reduced cylinder wall friction and the heating of the air. Dynamometer tests show cylinder wall friction to be about 60 per cent of the total cranking effort. Maintaining jacket water temperatures, therefore, reduces cylinder wall oil viscosity and the torque during cranking.

Viscosity of the lubricating oil is of great importance for upon it depends a high percentage of the torque required to crank an engine. Figure 3 shows the viscosity characteristics of some average oils. When there is no provision for maintaining heat in an engine, the low temperature viscosity should preferably be no higher than 50,000 Saybolt seconds. It is possible to crank engines with higher viscosities but it is seldom economical to supply the necessary electrical equipment to handle the high torque and therefore high current at voltages which will produce starting speed with oils having higher than 100,000 sec. at 0 deg. The necessity of knowing the viscosity characteristics of the oil, regardless of its S. A. E. number, should therefore be apparent.

Figure 4 shows the effect of speed upon the cranking torque, and while this variation is not as severe as that represented by lube oil viscosity, it nevertheless must be considered in selecting the minimum equipment which is required by different engines, particularly when attempting to start engines at very low temperatures where the torque is increasing rapidly with viscosity of the oil.

Without an automatic timing advance, which is just now coming into use, engine timing is a compromise to obtain the best possible fuel economy at operating speeds with the best setting for starting. The results of tests recently made to study the effects of the engine timing, plotted in Fig. 5, show the effect of varying the air intake heat at two extremes of timing 31 and 23 deg. before T. D. C., with a cranking speed of 100 r.p.m. It may be considered from the shape of these curves that as lower air temperatures increase the starting problem, a change in timing may have more effect than an economical increase in heat applied, and if no heat is applied to the engine, timing may well be the factor between a start and no start.

Starting motors as used on Diesels may be divided into three general classifications: the motor whose pinion on the armature shaft engages the teeth of the flywheel; the same motor but with an internal back gearing to enable it to produce still higher torque; and the third type which is normally a generator, direct connected to the engine crank shaft and having a heavy series field winding brought into use for the purpose of cranking.

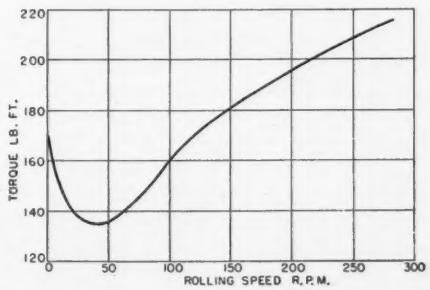


Fig. 4. Torque requirements as a function of cranking speed at 80 deg. F.

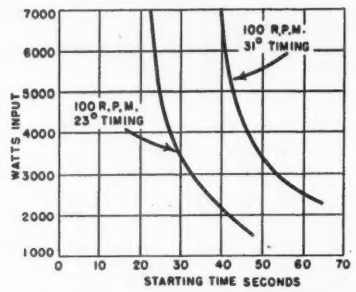


Fig. 5. Starting time is effected materially by injection timing. Both curves are from data taken at 0 deg. F.

The first type is used in general on the smaller engines developing up to 125 hp. since it requires a minimum of space. The second type is used on the larger engines when there is no direct connected generator and where the system voltage for starting must be kept as low as possible. The third type is nearly always used where there is a direct connected generator normally used in the production of power and when there is available a battery of sufficient voltage to provide cranking speed. Rail-car, marine and isolated plant installations are typical examples of this latter type.

It should be realized that there is a wide difference in the performance of starting motors and the selection of the cheapest motor may mean the purchase of the most expensive battery thereby offsetting by far the expected saving, initially, and forever thereafter. Starting motors must generally be selected from a stock of available sizes. The manufacturers have sufficient experience in this field to recommend a starting motor of adequate size but our experience is that the engine manufacturer or the vehicle manufacturer too often fails to provide space for an adequate motor, or will not pay the price for such a motor with the result that the plant required a battery that is larger than otherwise necessary, or it is actually assembled with undersized starting equipment throughout. For example, a certain engine without a back geared motor required a 12 cell 69 plate battery, and with the back geared motor a 12 cell 41 plate battery. The saving on the motor was $50.00, but the increased cost on the battery was $125.00.

We would like to caution those who consider the usual type of starting motor characteristic curve in selecting the proper motor, that unless they are thoroughly familiar with this type of curve, serious mistakes can be made. The horsepower curve for example refers only to that particular set of conditions of speed, voltage, torque and current prevalent at that moment. The horsepower developed by a series motor for any given torque is a function of the applied voltage, and, therefore, depends on the battery size.

This, as well as the torque-current and the speed-voltage relationships are shown in Fig. 6 which is the type of curve we prefer to use in making starting motor and battery selections. It will be noted that it is very easy to ascertain the current which will have to be supplied when the required torque from dynamometer tests is known. Likewise, for any required speed the necessary voltage is readily found by following the same current line vertically.

At the two common temperatures 80 and 0 deg. F., a battery has about 60 per cent of its normal temperature capacity and about 87 per cent of its voltage when operating at the same current rate at 0 deg. Therefore, if at battery, selected on the basis of 80 deg. F. starting, will be totally inadequate at 0 deg., or a battery properly selected to start the engine at zero, using one oil, may be inadequate if the oil is not changed as operating temperatures are reduced.

It has been our practice in selecting a battery for operation at low temperature to specify one which will when fully charged at the lowest temperature required, crank the engine under given conditions for 1½ min. If this battery is only half-charged, it will crank at firing speed for 40 to 45 sec. We do not believe it is safe to recommend a battery with less cranking ability to meet the average expectancy for low temperature starting.

Battery Maintenance

Proper maintenance of the battery is just as important as its proper selection, for the engine and its associated equipment are subject to criticism without proper battery care. The maintenance of the storage battery in Diesel engine installations requires the same attention as in other engine installations except that because of the probably longer use per day, the battery will require more frequent attention. With short shut-down periods it is obvious that the value of the charging rate is very critical and, therefore, must be controlled very close to the average requirements by slight corrections in either the voltage regulator setting or current setting in the care of two rate or third brush control to maintain the battery in a charged condition. The specific gravity should, therefore, be read periodically and a record kept to note changes and the direction of the change.

Rapid loss of water from the electrolyte indicates the necessity of prompt attention to charging conditions for under practically continuous operating conditions the battery may be seriously damaged in a few days if charging rates are excessive. Normal water usage should be approximately 1/10 ounce per plate per cell, each month. A 24 volt 25 plate battery thus would need 30 ounces.

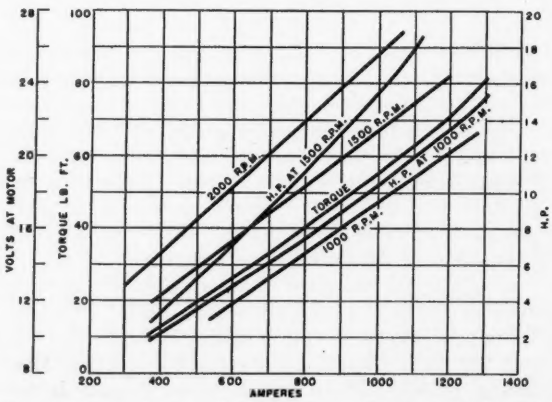


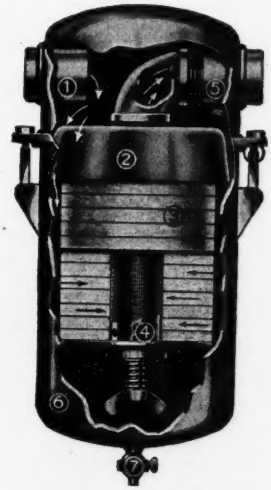
Fig. 6. The usual motor characteristics must be interpreted in the light of battery size and condition. The above curves show the torque and horsepower available at two different speeds and at different voltages

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

Protectomotor Air Filter

THE NEW Model AAPHS Protectomotor Air Filter, recently announced by the Staynew Filter Corp., is primarily designed for the removal of the oil from compressed air lines. The main feature of the new filter is a series of discs, possessing a large absorption area plus unusual filtering efficiency. These discs, made of Feltex, an exclusive felt-like material, are carried on a tube composed

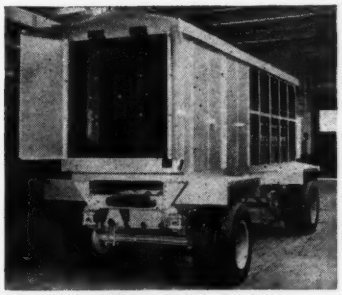


of an inner liner of perforated metal covered with a fine bronze wire mesh screen. This tube helps to drain oil removed from the air to the bottom of the filter shell, 6. The lower portion of the filter shell is easily removed for inspection or cleaning by simply loosening the nuts on the swing bolts, 8. A wide range of pipe sizes and filter capacities is available, ranging from ¼ in. pipe size for filter of 5 c.f.m. capacity to 2 in. pipe size for filter of 10 c.f.m.

Mobile Capacitor Unit for Pennsylvania Utility

A PORTABLE, trailer-mounted capacitor equipment, which can quickly be moved to any substation on the utility's system in case of an emergency, was recently built at General Electric's Pittsfield (Mass.) works for the Pennsylvania Power and Light Company. Completely assembled at the factory, the equipment has automatic control for varying the kv-a. as demanded by circuit voltage conditions. The mobile unit is believed to be the first of its kind.

The automatically switched equipment is rated 1080 kv-a., 2300 delta 4000



Y v., three-phase, 60 cycles. It consists of three sections of 180, 360, and 540 kv-a. By proper control, using a contact-making voltmeter as the master element, six capacitance steps are available: 180, 360, 540, 720, 900, and 1080 kv-a.

The portable block of capacitors is expected to be an important supplement to the large number of capacitor equipments permanently located on the utility's system, which embraces an area of approximately 9300 sq. mi.

Readily available to any of the system's substations, the mobile units will aid in releasing transformer capacity in case of emergency conditions, such as loss of transformer capacity or rapidly increasing loads which would overload existing transformers. It will also enable the utility to maintain voltage at different points in the system, compensating for seasonal shifts of load.

Total weight of the capacitor equipment is more than 14,000 lb. The equipment is mounted on a standard, high-speed 8-wheel type trailer which will connect to a tractor-truck by drawbar.

Photo Electric Outfit For Experimental Use

REHTRON CORP. Chicago manufacturers of photo cells and commercial photo electric equipment have adopted the novel method of developing and enlarging the market for their line by announcing a new, completely assembled photo electric and capacity relay experimental set at the very low price of only $17.50 net.

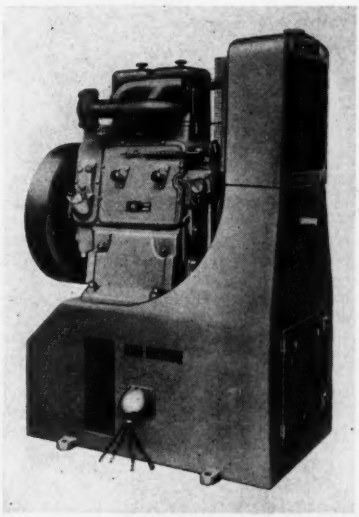
The set is not a toy or novelty but a simplified, multi-purpose apparatus consisting of a photo electric Robot Relay; a long range Light Source with invisible beam infra red filter; and a Signal-Switch Board equipped for both audible and visible signal demonstrations. A comprehensive, 24 page Instruction Book with diagrams and written in non-technical style so that anyone can understand, describes many practical applications and industrial experiments.

With the set, which comes all assembled and ready to plug into any 115 v. 50-60 cycle outlet, nearly all commercial applications of photo electric equipment can be demonstrated or duplicated.

The idea behind the introduction of this set is that only a comparatively few technical men are familiar with photo electric applications. Most manufacturers regard the photo cell and relay as some sort of magical stunt apparatus having only limited commercial applications. By providing a sensitive, stable, low cost piece of apparatus and making its operation and application understandable to laymen, as well as engineers, it is thought that photo electric principles and applications will be adopted more quickly. Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.

Diesel-Electric Unit

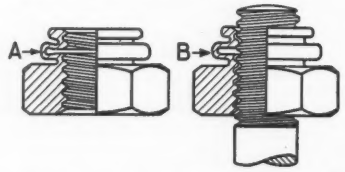
A NEW line of Diesel-electric power plants, ranging in size from 3600 to 24,000 watts is now being placed on the market by Lister-Blackstone, Inc., Milwaukee, Wis. These new plants, known as Powr-Pak units consist of a radiator cooled Lister engine using Bosch fuel system,



generator and control panel, all assembled in compact form. The generator sets directly underneath the engine and thus cuts floor space requirements almost in half. Generators are available in any desired voltage or current, either d.c. or single or three phase a.c., for stationary or marine service.

Self-Locking Nuts

THE BOOTS SELF-LOCKING NUT, made and distributed by Scovill Manufacturing Co., Waterbury, Conn., licensee of Boots Aircraft Nut Corp., is available in sizes from No. 8 to ¾ in. inclusive, in a variety of metals. It is essentially two nuts in one, with the top section displaced in a downward direction so that its upper (locking) threads are out of lead with respect to the load-carrying threads of



the lower section. The two sections are connected by a spring member which is an integral part of the nut. Upon the insertion of a bolt, the spring member allows the top section of the nut to be extended to permit it to engage properly with the threads of the bolt.

In the sketches above, A shows the spring member in its displaced position when not engaged with a screw or bolt. B shows the position of the spring member when the nut is engaged. Both sketches are exaggerated to show the principle involved.

Electric Stop-Watch

THE PRECISION SCIENTIFIC CO., 1751 N. Springfield Ave., Chicago, Ill., has placed on the market an electric stop watch under the trade name of "Time-It." This instrument is run by a synchronous electric motor whose speed is precisely controlled by the power house master clock which governs the cycle constancy of alternating current.

But instead of the ordinary watch dial the new electric stop-watch has a direct reading counter so that mistakes can't possibly be made in reading even to 1/10 second. Time intervals up to 2 hours 46 minutes, equivalent to ten thousand seconds, can be read directly to 1/10 of a second, easier than the ordinary stop-watch can be read to a full second. And the counter can be reset to zero from any reading.

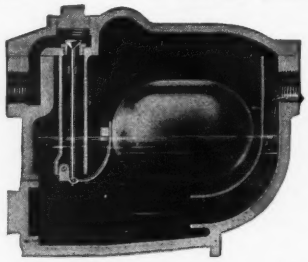
The new electric stop-watch can't be carried about in the pocket, but can be put to work wherever it can be plugged into a 110 v. a.c. line.

Refractory Walls

GEO. P. REINTJES CO., 2517-19 Jefferson St., Kansas City, Mo., has designed their walls so that insulation can be placed between the refractories and their horizontal box castings. Thus 90 per cent of their wall supporting metal is outside the insulation. In addition, all metal within the insulation consists of individual pieces of limited size so that cumulative growth is impossible. A cooling space or air lane is formed by attaching expanded metal lath and insulation to the outside of the Reintjes box supporting castings. At the same time this design provides a neat and finished appearance concealing all castings and permits the metal to be vented to further cool the castings without the use or expense of a metal casing.

Trap

WRIGHT-AUSTIN CO., Detroit, Mich., announces its No. 23-AC Trap which is recommended for use on compressed air service up to 125 lb. working pressure.



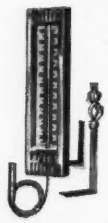
This trap of the simple float type is convenient to install because of the straight-line, horizontal pipe connections into the body of the trap. The valve in the trap opens outward above the seat in the same direction as the outgoing flow of condensate. This makes it possible to use a much larger orifice.

Lubricant for Gears

LUBRICANT No. 93, a new product of the Albany Grease Co., a Division of Adam Cook's Sons, Inc., Linden, N. J., is claimed to maintain a tenacious film on the surface of the gear teeth, obviate ing metal to metal contact which makes the gears run quietly. Being a grease, it requires little energy to disengage the teeth of the gears. It is resistant to and can be used in presence of water with no detrimental action.

Thermometer

THE NEW W59A Thermometer announced by the Minneapolis-Honeywell Regulator Co., 2950 Fourth Avenue South, Minneapolis, Minn., incorporates a remote bulb with a mounting clip to permit mounting the operating element where it will measure the temperature at the desired point within the duct. It is equipped with a universal mounting bracket which allows the face of the thermometer to point to the right, left or straight ahead, and also to point at any angle between vertical and horizontal.



Another model, the W59B, is similar to the W59A, except that it does not have a flexible element, but has a protecting well and is intended for insertion in water pipes or tanks. Both models have a standard range of −30 to +180 deg. F. It is 9 in. in height (the scale length itself is 6½ in.), 2$\frac{13}{32}$ in. width and $\frac{1}{16}$ in. in depth (the depth with the adjustable bracket is 3¼ in.).

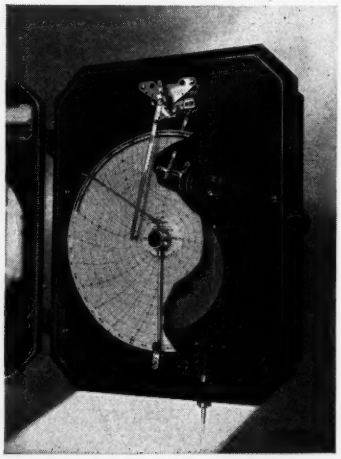
Exhaust Silencer

THE MAXIM SILENCER CO., Hartford, Conn., has developed two new Universal Exhaust Silencers, designated as the MUC and the MU1. The MUC embodies the same basic design and is intended for the same general applications as the improved MU1. It has been specifically developed to fill the need for a

more compact silencer unit of this type at a lower price. Both the MUC and the MU1 follow the Maxim theory of silencer design which prevents the creation of sound waves and pulsation waves as opposed to silencing them after they are created. The MU1, built for use as an exhaust silencer on two and four cycle internal combustion engines, and giving a high degree of silencing efficiency, is particularly adaptable to installations in business buildings, apartments or in residential districts where maximum noise attenuation is of primary importance.

Recorder

THE TAYLOR INSTRUMENT COS., Rochester, N. Y., have announced their new recorders for temperature, humidity, pressure, load, rate of flow, liquid level, and receivers for pneumatic transmission systems. The new universal case is for both face and flush mounting and can be mounted on panels side by side with the previous Taylor recorders. Dust and moisture are sealed from the case by Neoprene door gaskets and a positive bayonet-action latch. A die-cast alumi-

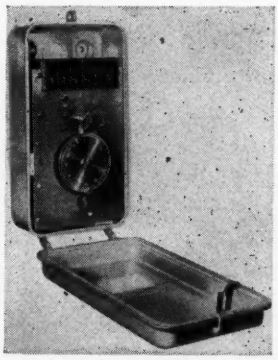


num chart plate gives a rigid surface for pencil notations on chart and for carrying the chart clamp and pen lifter. It is available with 10 or 12 in. charts, and with one, two or three pens

Bourdon actuating springs used with temperature and pressure systems possess the great strength and durability. An improved sub-base not only permits more accurate calibration, but also assures precise location of replacement systems in the field for optimum performance.

Relay

A NUMBER and variety of industrial operations can be precisely and economically controlled by the new Paragon series of Automatic Reset Timers and Time Delay Relays.



These Timers are furnished with eight terminals. A positive mechanical lock, magnetically operated, eliminates the need for friction and magnetic clutches and frees the Timer of trouble due to vibration. Engineering literature available from Paragon Electric Co., 37 West Van Buren St., Chicago, Ill.

Flexible Coupling

TWO NEW forged steel flexible couplings with 1⅛ and 1⅝ in. maximum bores respectively have been added to the Ajax line, announced by the Ajax Flexible Coupling Co., Westfield, N. Y.

Flanges are forged from SAE No. 1020 steel and are specially designed to meet the present trend of using alloy steel shafts carrying a high percentage of their torque capacity. Rubber bushings and graphic bronze bearings provide resilient flexibility, positive drive, free and float, and eliminate noise, backlash and lubrication problems.

Metal

HY-TENSO "X" has been developed by The Eastern Malleable Iron Co., Wilmington, Delaware, to meet the growing demand for a non-slip abrasive metal combining the strength and light weight qualities of steel, as well as the high noncorrosive properties of gray iron, at the same time eliminating the low shock resisting qualities of gray iron. A wide variety of products are being cast with this metal.

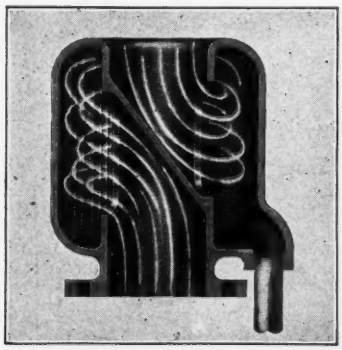
Nonslip Pulley Covering

A SPECIAL material invented some 40 yr. ago and applied to the face of pulleys to prevent belt slippage is now being manufactured on a commercial scale by the Nonslip Pulley Covering Co., 777 Hertel Avenue, Buffalo, N. Y. This product is called Nonslip Pulley Covering and comes in sheets containing 9 sq. ft. To apply Nonslip Pulley Covering the first

thing to be done is to see that the pulley is absolutely clean, then tear off strips of the proper width, soak for a few moments in hot water to soften the substance, and then apply tightly to the pulley as illustrated in the accompanying picture. A single application of Nonslip Pulley Covering usually lasts a couple of years and it is said that it eliminates practically all slippage and enables users of belt and pulley drives to get higher production from their machines.

Exhaust Heads

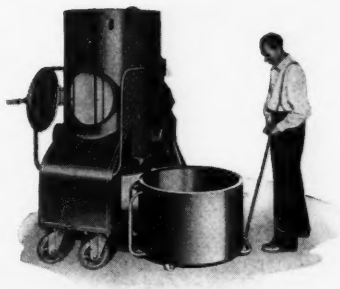
THE NEW exhaust head, made by the Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, incorporates the principles of the Cochrane baffle-type steam separators used for removing oil and moisture from steam lines. Exceptional port area produces low steam velocity and minimizes pressure loss. Steam is



whipped sidewise after passing through port and causes projection of entrainment against ribbed baffle surfaces. The high ribbed baffles exert a scrubbing action in addition to the centrifugal purging force The exhaust head is of one piece semi-steel construction for 4 to 12 in. size and of welded plate for larger sizes.

Cleaning Unit

A VERY unusual Heavy Duty Portable Vacuum Cleaning Unit, developed by the United States Hoffman Machinery Corp., Air Appliance Division, New York, N. Y., is known as the Hoffco-Vac Super-Duty Portable Cleaning Unit. It has a dust container capacity of 7½ cu. ft. of dust and the container is mounted

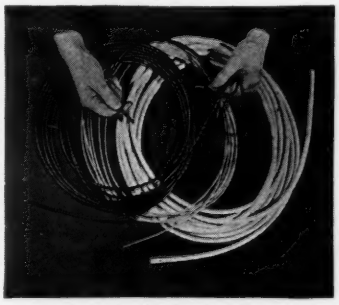


on wheels for easy handling. It can be used in conjunction with a modified piping system because of its high capacity. The machine is equipped with rubber tired roller bearing wheels which makes it very portable. The dimensions are, length 68 in., width 38 in., height 72 in. It is powered by a 5-hp. motor.

A New Extruded Tubing

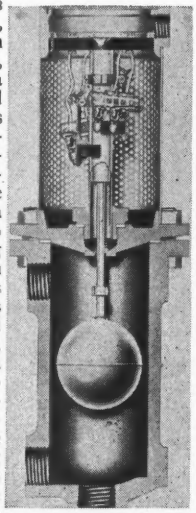
A NEW development in plastic materials is an extruded tubing manufactured by the Irvington Varnish & Insulator Co., 24 Argyle Terrace, Irvington, N. J. Irvo-o-lite Type XTE-30, as the tubing is known, is particularly fitted for use where flexible tubing plays an important part in wire insulation against heat, moisture, oils, etc.

Among the specific characteristics of this new extruded tubing are the following: excellent flexibility at all temperatures down to minus 4 deg. F.; extreme flexibility which permits bending on itself with wire inside without cracking, and returning to its original form after cutting, flexing or stretching; great resistance to tear and abrasion yet readily cut into desired lengths; high tensile strength, equal to 2150 lb. per sq. in. for No. 8 tubing; improved heat resistance without losing form up to 300 deg. F. and not affected at soldering temperatures; fire resistant when tested in accordance with A. S. T. M. specification D-350-39T; oil resistance sufficient to remain intact



and smooth when heated for 48 hr. at 220 deg. F. in Wemco or other transformer oil resistant to most coal tar solvents, denatured alcohol, petroleum solvents including gasoline, and acids and alkalies in concentrations up to 30 per cent by weight dielectric strength dry, 750 v. per mill up to .022 in. and wet, 350 v. per mill up to .022 in. It is produced in five standard colors from size No. 20 to 5/64 in. but can be manufactured in different sizes and wall thicknesses as specified.

Liquid Level Control

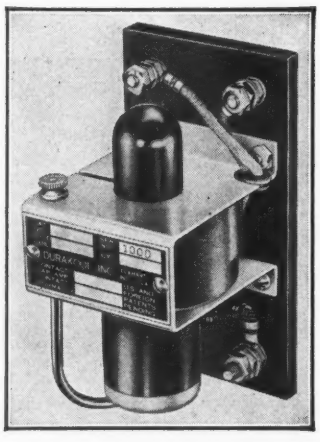


FRED H. SCHAUB ENGINEERING CO., 325 West Huron St., Chicago, Ill., has introduced a new liquid level control known as the Schaub Magnetrol. The switching action is obtained through the rise and fall of a piston attached to a float rod moving up and down in an enclosed tube. As the piston reaches a predetermined level in the tube, it comes into a magnetic field produced by a permanent magnet located on the outside of the enclosing tube. This causes the magnet to be drawn towards the piston which in turn causes a tilt action of a mercury to mercury switch, which is part of the magnet relay arm.

This control is available in 2 models. One has a single switching action which may be used as a low water cutoff. The other model incorporates three stages of liquid level control, low water cutoff, high water cutoff and stage control. An alarm circuit may be incorporated in either one of these models.

Mercury Relay

THE DURAKOOL MERCURY RELAY recently developed by Durakool, Inc., Elkhart, Ind., utilizes the metal body of a Durakool mercury switch and a solenoid. Since the contacts are hermetically sealed the relay is suitable



for use in corrosive or explosive atmospheres. It may be operated up to 300 times per min. Contact resistance is as low as 0.002 ohms. In a.c. as little as 1 watt is required for normal closing, and 1.5 watts for normal opening. In d.c. the operating energy is only 0.25 watts. For special purposes it is available for capacities up to 200 amp.

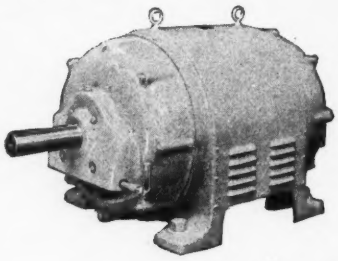
Emergency Lighting Unit

A NOVEL emergency lighting unit has been developed and placed upon the market by Triumph Explosives, Inc., of Elkton, Md. This unit consists of a fluorescent lamp in a reflector operating from a special 48 cell primary battery together with a wall panel. The panel consists of (1) a radium dial in the center that shines in the dark. (2) A main battery of 48 cells similar to the standard dry type except that they are packed and sealed in a dry state and energized only by turning a handle which releases the activating fluid. (3)

Two individual emergency lights which can be removed and and carried to more distant corners of the room. These operate on the same principle as the main lighting unit and light in less than a second when the bottom of the can is struck against any solid object. (4) A switch for testing the light on 110 v. a.c. without using the emergency battery. The important feature of this equipment is that the batteries never weaken—they cannot age because their energy is not born until it is needed.

Lubrication System

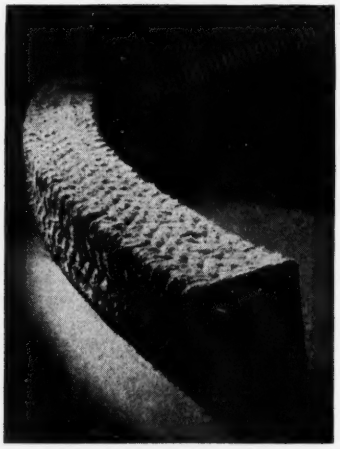
U. S. ELECTRICAL MOTORS, INC., Los Angeles, Calif., have just developed an oil lubrication system which is now being supplied on all open type SA and Uniclosed type SC motors larger than 30 hp. 3600 r.p.m. and 75 hp. 1800 r.p.m. An oil gage supplied on all oil lubricated



motors is marked with maximum and minimum level which may be easily checked. With oil lubrication complete and thorough lubrication is assured at all times since the oil level is maintained just slightly over the outer face of the bearing with the result that sufficient oil is always present and yet the bearing is never overloaded with oil.

Packing

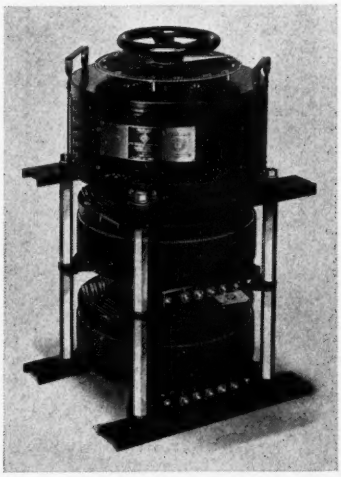
THE GARLOCK PACKING CO., Palmyra, N. Y., has introduced a new product known as the Garlock Lattice Braid Packing. It is manufactured by the patented Lattice-Braid process for which special machines have been designed. In



this type of packing every braiding strand passes diagonally through the body of the packing at an angle of approximately 45 deg., making a completely unified structure. This packing is offered in several types and kinds of material in sizes from $\frac{3}{8}$ to 1 in.

Variacs For 3-Phase Operation

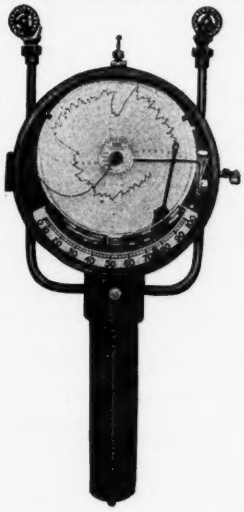
GENERAL RADIO Type 50 Variacs (5 kw. size) can now be provided in 2- and 3-gang combinations for use on three-phase circuits, and with current equalizing chokes for parallel operation on single-phase circuits.



Both 115- and 230-v. models are available. The 230-v., 3-gang, unit can be used in the wye connection on 560-v. circuits to obtain continuously variable output voltages from 0 to 560 v. with a maximum output of 30 kv-a. Because the Variac is an autotransformer, internal power losses are negligible. General Radio Co., Cambridge, Mass.

Flow Meter

A SIMPLIFIED flow meter for metering of steam, water, air or gas, is being placed on the market by the American District Steam Co., North Tonawanda, N. Y. Known as the ADSCO Flow Meter, it operates in conjunction with an orifice plate in the pipe line and records the flow on a large evenly divided chart by means of an exclusive, frictionless mechanism which is driven by a synchronous a. c. clock motor. The internal moving parts within the



meter comprise a magnet attached to a mercury container suspended from a spring. A fixed, internally shaped bell surrounds the lower portion of the magnet and forms a seal with the mercury in the container beneath it. The movement of the container is directly proportional to the flow through the orifice, and follower magnets in the external recording mechanism transmit the movement to a gravity-held pen arm which records on the chart. The ADSCO Flow Meter is offered in four types, (1) recording only, (2) recording and integrating, (3) indicating and recording, and (4) indicating, recording and integrating.

Duplex Recorder

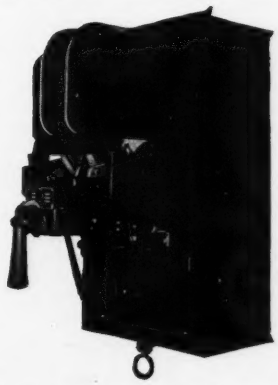
A NEW DUPLEX RECORDER for recording simultaneously kilowatts and rkva or kilowatts and frequency, or volts and amperes is announced by the General Electric Company. Designed originally for cement mills to record kiln speed and temperature simultaneously on a single chart, the new instrument may be had with any two of the elements formerly available singly in the Type CD instruments. It is expected to have a wide use wherever it is desirable to obtain synchronism between two separate records, or where space economy makes it necessary to place two separate recording mechanisms in a single case.

The duplex recorder consists essentially of two separate Type CD instruments placed side by side in one case and arranged to record on a single chart. Timed by a high-torque Telechron motor, or an 8-day spring clock, the chart carriage feeds the paper at 1, 2, or 3 in. per hr. Metal pins on each end of the timing drum, engaging in holes on each side of the record paper,

assure a positive drive. Each element, equipped with a conventional pen and inkwell, is calibrated for a 4-in. ruled section of the 10-in. wide record roll. Instead of a single wide chart, a separate standard Type CD chart carriage and chart may be had for each element.

Circuit Breaker

A NEW circuit breaker with maximum rating of 600 amp. has been developed by the I-T-E Circuit Breaker Co., Philadelphia. Designated as the Type KB, the interrupting capacity is such, that in a dust proof enclosure it can be rated at 20,000 r.m.s. amp. A new arc-quenching device developed for this circuit breaker is a more efficient form of the magnetic arc-quencher. Magnetic vanes, placed on the outside of insulating



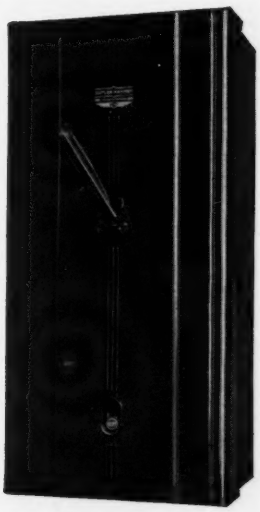
barriers, are magnetized with the opening of the arcing contacts, and the magnetic field thus set up forces the arc into an extinguishing chamber. Insulating barriers within the chamber cool the arc, create a turbulent gas condition and provide a cooling draft across the arc core. The materials selected and the arrangements made are such as to give maximum thermal capacity, maximum thermal and electrical conductivity, and a maximum turbulence of the gases. No deterioration of the arcing structure results when interrupting circuits, within the rated interrupting capacity of the circuit breaker.

Silica-Removal Treatment

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has developed Silimite, a special form of activated lime containing magnesia, which is highly effective in removing silica in hot process softeners. By means of special processing this product has been given a high absorptive capacity for silica, with maximum availability of calcium for softening. In plant operation, the Silimite is slaked in accordance with a definite procedure. The slaked Silimite and soda ash are then introduced into the softener and the operation is carried on in the same manner as with normal softening.

Combustion Starter and Disconnect Switch

A COMBINATION across-the-line starter and motor disconnect switch is a new product of Cutler-Hammer, Inc., Milwaukee, Wis. This starter, known as Bulletin 9589 starter is built for use with squirrel cage and single phase motors. Front operation permits close gauging of a number of units in compact width and height multiples. The all-in-one construction combining the across-the-line starter and motor disconnect switch and fuse in one enclosure saves wiring and conduit work.



By loosening four screws the entire control panel may be removed. Overload protection is provided by AC-H Entectic Alloy Thermal Overload relay which allows working the motor up to maximum limit safely, yet provides positive protection. The starter is available with either 3 or 4 poles, in 5 sizes, horsepower ratings from 6½ to 200 hp. and with the following types of cover control: reset button only; start and stop reset buttons, or 3 position selector switch for manual-off-automatic-local control.

Motor Oil

A NEW motor oil, designed especially to overcome certain difficulties encountered in the lubrication of automotive Diesels and gasoline engines in heavy-duty service is announced by The Texas Company, 135 E. 42nd St., New York, N. Y.

This oil, known as Texaco 303 Motor Oil, is applicable to the higher speeds, temperatures, and pressures in the newer types of heavy-duty Diesels and gasoline engines, assuring cleaner engines, higher maintained efficiency over long periods of continuous operation, with no harmful sludge or carbon deposits.

News from the Field

BEGINNING June 21, the University of Michigan will offer a special 8 wk. Internal Combustion Engine Institute covering the principles and design of automotive, aircraft and Diesel engines, advanced thermodynamics and engineering mechanics. This will be organized as part of the summer session. Fees for regular students working for credit are $35 for residents of Michigan, $50 for non-residents for those attending as visitors $20 and $25, respectively. Inquiries for additional information should be addressed to Professor E. T. Vincent, Mechanical Engineering Department, University of Michigan, Ann Arbor, Mich.

THE 1940 ANNUAL convention of Stoker Manufacturers Association will be held at The Homestead Hotel, Hot Springs, Virginia, on Thursday and Friday, June 6 and 7. The first day's sessions will be limited to members and stoker manufacturers and invitations have been sent out to members of the industries allied with the stoker industry to attend Friday morning's, June 7, general session and to participate in the annual golf tournament and annual banquet later that day.

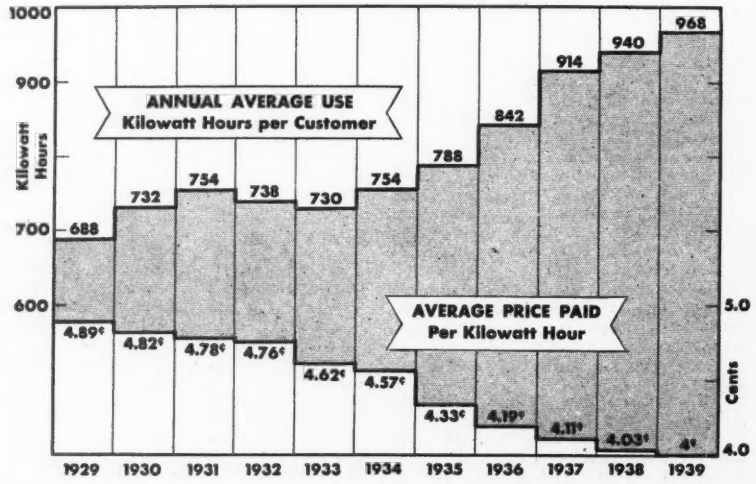
THE MANUFACTURERS' DIVISION of the American Mining Congress has elected Arthur S. Knoizen, Vice President, Joy Mfg. Co., as its chairman for the coming year. The following were named to the other offices in the Division: 1st Vice-Chairman, E. J. Burnell, Link-Belt Co.; 2nd Vice-Chairman, E. F. Carley, E. I. duPont deNemours Co.; 3rd Vice-Chairman, J. W. Haddock, Sullivan Machinery Co.

AT THE election of officers, held April 29, 1940, in Pittsburgh, the American Society for Measurement & Control elected R. J. S. Pigett, head of the Engineering Department of the Gulf Research and Development Co., Harmarville, Pa., as President.

ANNOUNCEMENT has been made by J. E. Tobey, vice president in charge of engineering for Appalachian Coals, Inc., that the twenty-sixth fuel engineering conference would be held in Washington, D. C., June 21, at the Shoreham Hotel, this being the first time the A. C. I. engineers have scheduled a meeting in the east. Since 1934, twenty-five conferences have been held in the middle west and south, the last having been held at Ann Arbor, Mich., April 22, upon invitation of the University of Michigan. Industrial executives, fuel engineers, power engineers and others interested in fuel technology from the Carolinas to Maine, Tobey stated, are being invited to attend this conference. It will be a one-day session, largely educational in nature.

V. L. SHERMAN has been elected president of the Illinois chapter of the American Society of Heating and Ventilating Engineers. He is now an associate professor of mechanical engineering at Lewis Institute but is leaving this summer. Other officers elected were: Vice president, I. E. Brooke, consulting engineer; secretary, M. W. Bishop, with the American Blower Co.; treasurer, E. M. Mittendorf. W. A. Kuechenberg, A. O. May, L. J. Pitcher, and Tom Brown, retiring president, were elected to the board of governors.

ELMER L. LINDSETH, technical assistant to the president of the Cleveland Electric Illuminating Co., was recently nominated for president of the Case Alumni Association. Charles F. Chapman, the alumni secretary, announced that the nomination was unopposed and Mr. Lindseth will be inducted into office at the 55th Annual Alumni Reunion Banquet to be held at the University Club in Cleveland on June 1. Mr. Lindseth, of the class of 1925 and the youngest man ever nominated for the office, has been with the Cleveland Electric Illuminating Co. since 1926.



The March of Progress—as pictured for a 10 yr. period in the 1939 annual report to stockholders of the Duquesne Light Co.

WALTER S. RUGG, aged 74, retired vice president of the Westinghouse Electric & Mfg. Co.. died April 25, in New York, after a heart attack. He was born in Broadhead, Wisconsin, and attended Laurence College and Cornell University, receiving a Master of Science degree from the latter in 1892. Following his graduation he began his electrical career as a student engineer at Westinghouse.

GUY LYNFIELD BAYLEY, a partner in the engineering firm of Sanderson & Porter, died of coronary thrombosis on April 21. He was 69 yr. old. He was born in Vacaville, Calif., and was graduated from the University of California. He had been a partner in Sanderson & Porter since 1930. His wife, two sons, a brother and a sister survive.

RALPH NOYES ROBERTSON, treasurer of Bradshaw & Co., Pittsburgh, Pa., died suddenly on April 30 at the age of 64 years. He was a graduate of Colorado College and Cornell University, receiving from the latter an honorary degree for original research. In 1933 he joined Bradshaw & Co. as Chief Engineer and also as Treasurer, which position he held at the time of his death.

Gen. Falk, Allis-Chalmers Head, Dead

GENERAL OTTO H. FALK, Chairman of the Board of the Allis-Chalmers Mfg. Co., died at his home in Milwaukee, Wis., on May 21st. He had been ill since last fall with a heart ailment.

General Otto H. Falk

Otto Falk was born in Milwaukee in 1865. After attending the German-English Academy in Milwaukee and the Northwestern College at Watertown, Wis., he enrolled in the Allen Military Academy at Chicago and was graduated as Captain. He had a definite bent for military life and for many years afterward was active in the national guard and in 1894 was made adjutant general.

The most conspicuous work of Gen. Falk in the industrial and financial field was his reorganization of the old Allis-Chalmers Co. into the present Allis-Chalmers Mfg. Co. He was made receiver of the Allis-Chalmers Co. in 1912 and a year later was elected president of the reorganized concern. Some years later he was made chairman of the board.

Gen. Falk's dynamic energies could not be confined to one venture. He busied himself not only in private companies but in outside interests. The general was active in Red Cross work. He was a member of the board of directors of the Milwaukee county chapter of the Red Cross and chairman of its disaster relief committee. In each roll call campaign for memberships he headed the industrial solicitation committee.

Gen. Falk was a member also of the United States Infantry association, the Military Service institute, the American National Red Cross, the National Guard association of Wisconsin, the Wisconsin State Rifle association, the Military Order of Foreign Wars and the Spanish-American War Veterans' association. He was also selected on two occasions as the city's outstanding citizen.

Manufacturers' News

CUTLER-HAMMER, INC., Milwaukee, Wis., announces that G. E. Hunt has been appointed to take charge of the company's Indianapolis office which is under the direct supervision of C. J. Maloney, manager of the Chicago district sales territory.

THE TERRY STEAM TURBINE CO. announces the appointment of The Northwestern Power Equipment Co., 2295 University Avenue, St. Paul, Minn., as sales representatives for Terry turbines, gears and turbo-generator units.

THE CORPORATE title of the Eisler Electric Corp. has been changed to Callite Tungsten Corp.

THE COOPER-BESSEMER CORP. announces that John Rogers has joined its organization in a sales engineering capacity and will soon take up his duties as Pacific Coast manager of the company's Los Angeles offices. J. W. Reed has been transferred from the Los Angeles to the New York offices as Atlantic coast manager of the corporation's Gas Engine and Compressor division.

HARBISON-WALKER REFRACTORIES CO. announces the purchase of the Athens plant of the Athens Brick & Tile Co., Athens, Texas. Coleman brand of fireclay brick will continue to be made with improvements in quality and workmanship and complete stocks will be maintained.

GRINNELL CO., INC., Providence, R. I., announces the appointment of James D. Fleming as Vice-President and Sales Manager. He formerly was Vice-President and Manager of the Grinnell Co. of the Pacific, a subsidiary. He has been associated with that company since 1919.

JAMES R. SHELDON, president, announces the formation of the International Diesel Electric Co., Inc., 7 Dey street, New York city, for the purpose of conducting a general power equipment business. specializing in Unitized Diesel electric installations employing the Strong automatic control patents. The firm of Murray and Flood have been engaged as consulting and management engineers.

ALLIS-CHALMERS' MFG. CO., Milwaukee, Wis., has obtained the order covering the third hydraulic turbine and governor for the Pickwick Landing Station of the T.V.A. The new unit will be rated 48,000 hp. at 81.8 r.p,m. under 43 ft. head.

L. R. HOFF, vice president of Johns-Manville Corp., in charge of all sales, was honored at a luncheon on May 6 by the Officers Board of Johns-Manville on the completion of his fortieth year of service with the company. He was presented with a gold watch chain by Lewis H. Brown, president of Johns-Manville Corp.

NORTHERN EQUIPMENT CO., Erie, Pa., announces the appointment of Meleney Engineering Co., Washington, D. C., as district representative for Copes feedwater regulators, differential valves, pump governors, desuperheaters, pressure reducing valves and allied equipment.

THE CUTLER-HAMMER office and warehouse in Atlanta, Ga., has been moved to a new location at 134 Marietta St., N. W. This office is in charge of A. C. Gibson who has had wide experience as a sales engineer in the application of Cutler-Hammer products in the various industries of this territory .

The company also announces the appointment of O. P. Robinson to the Cutler-Hammer Pittsburgh Sales Engineering Staff.

THE MARLEY CO., Kansas City, Kan., announces the removal of its New York city sales office to 2 Rector street.

ROBERT M. GATES, vice-president of the Superheater Co., has been named president of the Air Preheater Corp.

JOSEPH V. SANTRY has been elected president of the Combustion Engineering Company, Inc., succeeding Frederic A. Schaff, who was elected vice chairman of the board. Martens H. Isenberg, formerly vice-president in charge of production, was elected executive vice-president to succeed Mr. Santry. Robert M. Gates, who has been vice-president in charge of sales since 1933, resigned to accept the presidency of The Air Preheater Corp.

New Construction

CONTRACT has been awarded to The H. K. Ferguson Co., Cleveland, O., for the construction of buildings and installation of equipment of a complete new soap and soap products plant at Dallas, Texas, for The Proctor & Gamble Co. The present power plant will be completely revised, including the installation of high pressure boilers and turbines.

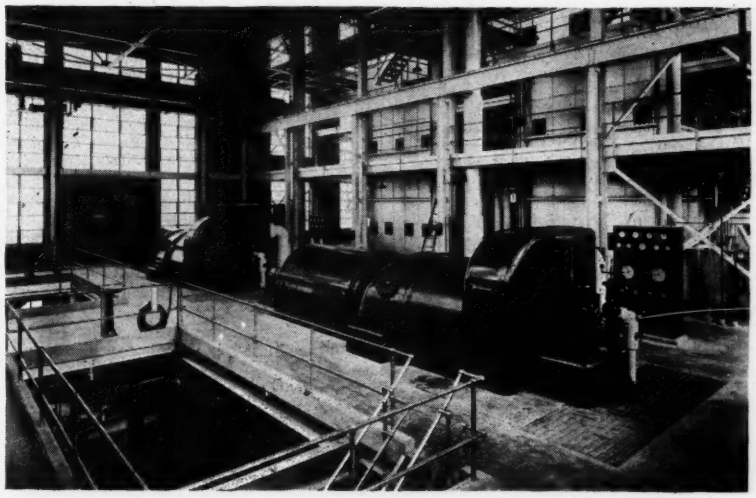
Topping Unit for Joliet

PLANS have been made by the Public Service Co. of Northern Illinois to change the steam conditions on its Joliet station from 300 lb. pressure and approximately 600 deg. F., to 1250 lb. pressure. A 25,000-kw superposed turbine-generator now being built by the General Electric Company will be installed during this modernization program. This new turbine-generator will provide the additional 25,000 kw. of generating capacity for about 5300 B.t.u. per kw-hr. and effect better than a 20 per cent reduction of heat rate. The modernized plant will take the same amount of cooling water to produce 75,000-kw. as was formerly required for 50,000.

The development of the modern turbine generator can very well be summed up in the history of the Joliet station. When its first two units, 10,000-kw., 300-lb., 622 deg. F., were purchased in 1916-17, they were in advance of their time in steam pressure and temperature. In 1922, a 30,000-kw., 300-lb., 650 deg. F. unit was added. The present installation is the third in 24 yr. by which the Joliet station has been brought up to date with General Electric equipment.

Buffalo Niagara Electric Corporation to Expend $3,500,000

THE BUFFALO NIAGARA ELECTRIC CORP., Buffalo, N. Y., is securing through the Niagara Hudson Power Corp., Buffalo, parent organization, a fund of $3,500,000 for extension and improvements



They Help Make Nylon

POWER for the duPont Nylon plant at Seaford, Dela., is provided by these two 9378 kv-a., 3600- r.p.m. 11,500 v., 3-ph., 60-cycles, 80 p.f. Westinghouse turbine generators which take steam at 525 lb. 700 deg. T. T. and exhaust to condensers at 2 in. Hg. absolute. At 20 lb. gage a portion of the steam is extracted automatically for plant use. Each generator has a 46-kw. direct-connected exciter.

in plants and system during the present year. Program will cover power plants, power substations, transmission and distributing lines; both overhead and underground line construction will be carried out in Buffalo area, as well as extensions in street-lighting system. Line work will represent an expenditure of close to $1,000,000 of the gross appropriation noted. Company also will proceed with completion of a new service and operating building on Dewey Avenue, to cost about $300,000, with equipment. Work on different features of the program will be placed under way soon.

The Niagara Hudson organization, noted, also has made allotments for other utility properties in the same area, including $2,600,000 for the Niagara, Lockport & Ontario Power Co., Buffalo, to be used for power stations and lines; and $869,000 for the Niagara Falls Power Co., Niagara Falls. Included in the program for the latter company is the rebuilding of one of the hydroelectric generating units at the Schoellkopf power plant, and the installation of a transformer bank at the Harper Station.

Coal Handling Changes at Valmont

At the Valmont power plant, Boulder, Colo., a new system for handling pulverized coal has been installed. The old bag filters have been replaced by a new method using multiple cyclones designel by John Elftman, superintendent of the plant, and his engineers. A nest of 63 small filters is installed in the No. 5 mill while a battery of 136 units is used in the large No. 6 mill.

Nantahala Power Company to Build Hydroelectric Plants

The Nantahala Power Co., Franklin, N. C., has plans in progress for the early resumption of construction of hydroelectric power development on Nantahala River, Macon County, N. C., where work was begun a number of years ago and later discontinued. Projects will include an earth-faced, rock-filled power dam, 260 ft. high and 880 ft. long, power station building and installation of hydraulic turbines and generators with initial capacity of 63,000-kv.a. The new dam will create an artificial lake of about 1631 acres, for water storage service. Project will include a terminal switching station, transformer house and line extensions to connect with present transmission system of company. Up to the present time, the company is stated to have expended close to $1,000,000 in the development of the power site, and an equal amount is estimated to be required for ultimate completion. At same time company also proposes a second new similar hydroelectric power development in the vicinity of Glenville, Jackson County, N. C., where site has been selected on the West Fork of the Tuckasegee River. This project will comprise a power dam of same type as noted, 148 ft. high and close to 820 ft. long; power house will be provided with hydraulic turbines and generators for an initial rating of 30,000-kv.a. A transmission line will be built to tie in the two stations. Power output will be used in part by the Carolina Aluminum Co., Badin, N. C., an affiliated interest, with remainder for general distribution to industrial and commercial consumers in company territory. J. E. S. Thorpe is president of company, which has made application to the Federal Power Commission for authority to proceed with program.

Proposed Kings River Power Development—California

Following studies and investigations for about 24 months, John C. Page, United States Commissioner of Reclamation, Washington, D. C., has recommended an irrigation, flood control and power project on the Kings River in Central California, and the program has been submitted to Congress by the Secretary of Interior for final authority and necessary funds. The report covers the construction of a dam at a place known as Pine Flat on the Kings River, to be a concrete structure about 413 ft. high, designed to impound approximately 1,000,000 acre-feet of water. The hydroelectric power plant, to be situated at this point, will have an initial capacity of 15,000-kw., with transmission lines to extend to different points in the district, as well as a line for connection with the power system of the Central Valley project of the Bureau of Reclamation, now in course of construction. The report further recommends for future consideration, but not for immediate inclusion, a large hydroelectric power development on the North Fork of the Kings River, in the immediate vicinity.

The initial project is estimated to cost $22,300,000, of which about $9,950,000 would be allocated to the irrigation part of program, to be repaid by water users on 800,000 acres of land to be benefitted by the development, a sizeable acreage of which is located in the vicinity of Fresno. A similar sum, $9,950,000 would be allocated to flood control; and $2,600,000 would be appropriated to the power development for prepayment from power sales in a period of 40 years. Annual costs for power generation are estimated to be but $174,000, including local distribution, and it is expected that the benefits each year would be $677,000 through the use of power from this source and neighboring sections of the transmission system of the Central Valley project.

Central Indiana Power Co. to Proceed with Power Development

The Central Indiana Power Co., Traction Terminal Building, Indianapolis, Ind., has completed plans for construction of a one-story power house, 104 x 145 ft., at its hydroelectric power development in vicinity of West Terre Haute, Vigo County, Ind., and will proceed with superstructure at once. The station, it is stated, will be equipped for an initial rating of about 50,000-kw. Company has been active in this development for a number of months and proposes to push the work to completion at earliest date. Transmission lines will be built for connection with main high-tension system, with switching stations and other operating facilities. Entire project is reported to cost over $2,500,000. Award for construction of power station building has been made to J. L. Simmons Co., Union Title Building, Indianapolis. Sargent & Lundy, Inc., 140 South Dearborn Street, Chicago, Ill., is consulting engineer.

For the Engineer's Library

Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Controls Meters and Instruments

Ohmmeters—Bulletin 1635 describes the "Ducter", a new low resistance ohmmeter. This, as explained in the bulletin, is one of the "Megger" family of resistance measuring instruments. It will measure resistances down to one-millionth of an ohm as easily as high resistances are measured by the ordinary "megger" insulation tester. Measurements are made merely by reading the position of a pointer over a scale. There are no manipulations or adjustments to make, not even for the voltage of the battery that supplies the necessary test current; and there are no calculations. James G. Biddle Co.

Pump Governors—Catalog 70 illustrates and describes 7 different types of pump governors giving application, operation and installation instructions. Foster Engineering Co.

Voltage Regulators—A F R ⅝ per cent step feeder voltage regulators, built for regulating voltage under load on feeders and buses from 1200 to 66,000 v. in ratings up to 750 kv-a, are described in Bulletin B-6056. They are made in a large number of standard 3 phase sizes to provide plus or minus 10 per cent regulation in thirty-two ⅝ per cent steps but can be supplied with practically any range of regulation for both single or three phase circuits. Allis-Chalmers Mfg. Co.

Instruments—A new 24-page illustrated catalog E-50B(3), entitled Type K Potentiometers and Accessories, describes and lists the two Type K Potentiometers, K-1 and K-2. Galvanometers and other accessories suited for use with these instruments are also described. An added feature is the picture and description of the Thermionic Amplifier which adapts potentiometers to measurements in high-resistance circuits, such as those for pH measurements using the glass electrode. Leeds & Northrup Co.

Instruments—The Control of Speed is the title of a new catalog devoted to hand tachometers, speed indicators, cutmeters and various other types of speed measuring equipment and instruments that are used for measuring revolutions per minute of electric motors, machinery, engines, lathes, pumps, Diesel engines, elevators and practically all types of industrial equipment. George Scherr Co., Inc.

Specifications—Three new specification sheets cover resistance standards, bridges, and special apparatus, respectively. These bulletins will enable the engineer and laboratory worker to choose the instruments having suitable characteristics for the work at hand, whether testing, instruction or research. Shallcross Mfg. Co.

Voltage Control—A new broadside GES-2285 illustrates and describes the type Airs Regulator. General Electric Co.

Electrical Equipment

Fluorescent Luminaires—A new four page illustrated booklet, F-8500, describing a twin lamp fluorescent RLM type luminaire contains a complete written description of the fixture, including spread and cut-off values, and its operating power factor. Design data including distribution curves, dimensional sketches, and a table giving calculated foot-candle intensities obtained with various spacing arrangements and mounting heights is given in the booklet. Westinghouse Electric & Mfg. Co.

Electric Products—Catalog 402 containing 88 pages is devoted to safety switches, service equipment, lighting panels, Saf-to-Fuse Panels, Kbl-duct, circuit breakers and miscellaneous devices. Prices, specifications and dimensions are included in the catalog. Bull Dog Electric Products Co.

Steel Poles—A 4-page illustrated folder (HD-306) describing Monotube Steel Poles lists advantages and construction features of the product and also contains many installation photographs showing the various services for which these poles are adapted. The Union Metal Mfg. Co.

Wire and Cable. The Simplex Wire and Cable Co, 79 Sidney St., Cambridge, Mass., have issued a new edition of "The Simplex Manual." This is a handy and extremely useful, 270 page handbook of data on wire and cable for electrical engineers, contractors and wiremen. It contains many tables and a great deal of engineering data useful in the solution of transmission and distribution problems. Bound in an attractive red simulated leather binding and measuring 4¼ by 7 in., it forms a most useful "pocket" handbook.

Design and Operation of U. S. Single Phase Motors is the title of a new educational booklet which deals with mechanical and electrical characteristics of single phase, capacitor start motors and is illustrated with diagrams and charts. U. S. Electrical Motors, Inc.

Electrical Equipment—Three new bulletins have just been issued discussing various types of electrical equipment. The numbers and subjects of the bulletins are: GEA-3345, Synchronous Motors and Control for Part-Winding Starting; GEA-2902B, Vacuum-Tube Time-Delay Relay; GEA-1607C, Direct-Current Generators and Exciters, Type B. General Electric Co.

Boilers and Accessories

Pneumatic Coal Cleaning—A new illustrated Folder No. 1821 on pneumatic coal cleaning covers the Link-Belt American System, which de-dusts and drys as it cleans. "Y" type double-deck and "Twin-Dex" type tandem-deck pneumatic separators are illustrated. Link-Belt Co.

Boiler and Tank Accessories—Catalog 10 gives technical data and general information about boiler and tank accessories including manhole cover assemblies, handhole cover assemblies, welding street ells, welding fittings, standard flanges, water column ells and welding necks. The Steel Improvement & Forge Co.

Stokers—A new 8-page, tabloid size, rotogravure catalog No. 1782 on automatic coal stokers covers the method and advantages of stoker firing, and particularly stressing the Link-Belt Magic Flame combustion principle. It also covers the company's line of domestic bituminous stokers, both hopper type and bin-fed; anthracite models, hopper and bin-fed types, with or without ash removal; and commercial and industrial bituminous stokers for boilers up to 300 hp. The Link-Belt Co.

Beam for Motor Truck Scale—A new 4-page bulletin illustrates and describes the new Fairbanks full capacity beam for motor truck scales. Nine features of the new product are given in the bulletin. Fairbanks, Morse & Co.

Wire Rope Clip—A new 4-page folder illustrates and describes a new U-bolt wire rope clip, covering construction and ease of application. Thomas Laughlin Co.

Piping

Fittings—Catalog 3, containing 40 pages, covers numerous types of blast-furnace and steel plant fittings, giving sizes and prices. Four pages of useful engineering information are included in the catalog. Pittsburgh Brass Mfg. Co.

Flexible Metal Hose—Interesting developments in flexible metal hose engineering are contained in a new catalog G-21. Technical data and illustrations cover the use of flexible metal hose for saturated steam and superheated steam, for the conveyance of fluids and chemicals, and numerous special uses. Two distinct types of tubing, annular corrugation (Rex-Weld) and spiral wound (Rex-Tube) are treated comprehensively, providing a valuable reference guide. Chicago Metal Hose Corp.

Flexible Piping—General Bulletin No. G-5 illustrates and describes Penflex Metal Hose, a flexible piping for air, oil, steam, gases and volatiles. Bulletin 90 describes Penflex Weld High Pressure Flexible All-Metal Tubing. Pennsylvania Flexible Metallic Tubing Co.

Valves—A new 12-page catalog illustrates and describes a complete line of small steel valves including gates, angles, globes, and checks. Sizes, prices, and pressure temperature ratings are included in the bulletin. Crane Co.

Welding—A new catalog WT 29 covering WeldOlets and ThredOlets—welding outlets for piping—illustrates and describes in detail various types of outlets. It also gives in detail various types of piping installations on which they have been used. Bonney Forge & Tool Works.

Pipe Tools—A new pocket size folder illustrates and describes the No. 71 Kit Box and Models A, B, C, Beaver Pipe and bolt machines, giving application, sizes and prices. Beaver Pipe Tools, Inc.

Flanging and Pressing—Catalog No. 1, containing 132 pages, entitled Lukens Flanging and Pressing, gives the complete history of the Lukens Steel Co. and shows the progress made. The equipment is completely described, gives list prices, specifications and supplementary technical data. Lukens Steel Co.

Steel Valves and Fittings—A new catalog No. 40-S containing 306 pages is devoted exclusively to steel valves and fittings, and kindred steel specialties and accessories, and, in addition, contains engineering data pertaining to high pressure-temperature piping problems. The method of indexing this new steel catalog makes it easy to turn immediately to the section wanted. It should be a valuable asset to all engineers, piping contractors, purchasing agents, industrial executives, and others who are interested in high-pressure, high-temperature piping materials that reflect the latest developments in design and metallurgy. Crane Co.

Prime Movers

Turbines—A new 28-page illustrated booklet B-2230 describes general purpose impulse turbines for condensing or non-condensing service and designed especially for industrial and central station applications. The sizes cover the range from 5 to 1500 hp. and of inlet steam pressures up to and including 600 lb. and 750 deg. Complete descriptions of the turbines are given, including a list of standard equipment and accessories furnished with the turbines. General material specifications are tabulated in easy readable form including all necessary information. Westinghouse Electric & Mfg. Co.

Water Works System—An 8-page leaflet describes and illustrates the Kansas City (Mo.) Water Works System. Following a brief account of the historical development, the settling, coagulating, filtering and treating arrangements, together with the several pumping stations, are described in the text and by means of a map, and operations for the fiscal year ending April, 1939, are tabulated. De Laval Steam Turbine Co.

Heating Equipment

Heating Equipment—Six new bulletins have just been issued describing various types of heating equipment. The numbers and subjects of the bulletins are: GEA-214D, G-E Calrod Immersion Heaters; GEA-1157C, G-E Strip Heaters; GEA-1265D, G-E Thermostats for use with midget heating units; GEA-2592A, G-E Unit Heaters; GEA-2618A, G-E Fin Calrod Heating Units; GEA-104B, G-E Cartridge-Type Heating Units. General Electric Co.

Oil Burner—A new 4-page bulletin illustrates and describes the duplex flat flame oil burning furnace. W. J. Campbell & Son, Inc.

Materials

Refractory Concrete, made with Lumnite, is described in a 24-page, illustrated booklet. Methods of making refractory concrete for low, medium and high temperature furnaces are given. Heat resistant concrete for the construction of flues and ducts, as well as foundations and floors exposed to soaking heat, is also described. There are tables of mixes with conductivity factors for a variety of insulating concretes used in industrial furnaces. The Atlas Lumnite Cement Co.

Chemicals—The latest edition of the catalog entitled Chemicals by Glyco is now ready for distribution. This comprehensive 96-page catalog describes glycol and glyceryl esters, emulsifying agents, special emulsions, synthetic waxes, synthetic resins and a number of specialties of wide interest and application. Glyco Products Co., Inc.

Refractories — Comprehensive data on Sillimanite refractories—brick, cement and plastic, are given in the new Bulletin No. 209. General Refractories Co.

Mechanical Power Transmission

Leather Belts and Packing—A new type of catalog on transmission belting has been published in which information is condensed, tabulated and so arranged that it is convenient to select the proper belt for each type of drive requirement. Information on belt dressings and cements is included; also suggestions on belting installation and maintenance and instructions on how to select the proper belt for the drive. Graton & Knight Co.

Bearing—The 1940 edition of the Johnson Bronze General Catalog, identified as Catalog 400, lists over 800 sizes of plain bearings and describes more than 350 listings of bronze bars. Many new numbers were added to the Electric Motor Bearing section and each bearing is illustrated. Other items such as graphited bronze, Ledaloyl self-lubricating bearings and babbit are included. Johnson Bronze Co.

Safety Equipment

Safety Goggles — A set of simple rules on the care of safety goggles have just been published in the form of an illustrated bulletin. Featured in the bulletin are proper methods of sterilizing goggles, instructions on proper goggle adjustment and loopholes. American Optical Co.

Safety Clothing—A new 14-page catalog of safety clothing, has just been published which shows more than 3800 items, gloves, mitts, finger guards, hand pads, sleeves, arm protectors, aprons, leggings, spats and welder's protective equipment. Industrial Gloves Co.

Safety Equipment—A new 136-page catalog, entitled "Everything for Safety" illustrates complete protection for man and machine. Some of the principal subjects covered are eye, face and head protection, machine tool guards of various types, safety tongs, vacuum lifters, ejectors, clothing and gloves. The Boyer-Campbell Co.

Miscellaneous

Purger—The Armstrong Foul Gas Purger is illustrated and described in a new 8-page bulletin, covering installation, application and operation. The bulletin also describes the Armstrong high side float, giving construction, operation and installation. Armstrong Machine Works.

Books—The new 1940 catalog of Important Technical and Scientific Books contains many important new titles. Books of importance in all technical and scientific fields have been added to the previous standard and authoritative works. Chemical Publishing Co., Inc.

Sales and Engineering Developments—Allis-Chalmers Mfg. Co. this year for the first time has prepared its "Annual Review of Sales and Engineering Developments" for distribution to a selected list of persons outside of their own organization. This makes an attractive 90 page book, illustrated with numerous beautiful photographs and containing data prepared by the various department heads and engineers of the company.

Index to Standards—The Latest edition of the Index to A.S.T.M. Standards, including Tentative Standards, gives information on all of the 885 standards as of January 1, 1940. The Index is of service to anyone wishing to ascertain whether the Society has issued standard specifications, test methods, or definitions covering a particular engineering material or subject and it is of help in locating the standards in the volumes where they appear. Copies of this 152-page publication are furnished without charge on written request to A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa.

New Engineering Books

The Engineering Experiment Station of the University of Illinois, Urbana, Ill., has recently published a number of bulletins, including: Bulletin No. 319 on the Laminar Flow of Sludges in Pipes with Special Reference to Sewage Sludge, by H. E. Babbitt and D. H. Caldwell; and Circular No. 40, German-English Glossary for Civil Engineering, by A. A. Brielmaier. The first is concerned with data for the design of pipe lines in which sludges will flow or be pumped. Heretofore common hydraulic formulas have been assumed but actual measurements indicate that this assumption is only an approximation of the true conditions. As a result of the investigation it has been shown that sludges, such as mixtures of clay and water, sewage sludges, sludges from water-softening plants and similar aqueous suspensions of fine particles, obey the fundamental formula for the flow of a true plastic. Formulas have been developed and verified experimentally.

The second circular is well explained by the title. The words used were compiled from several representative modern German works on civil engineering and from current technical periodicals.

Bulletin 319 sells for 65 ct. per copy, and Circular No. 40 for 45 ct. per copy. A limited supply is available for free distribution until Sepember 1, however, and may be obtained without charge on application to the Engineering Experiment Station.

Electrical Year Book, 1940. 376 pp., 4 by 6 in., illustrated, cloth. Published by Emmott and Co., Ltd., 31 King St., West, Manchester, England. 1/6 net (approx. 38 cents).

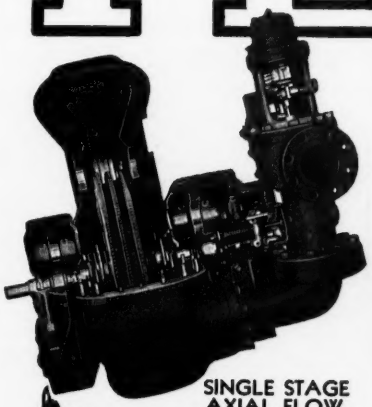
For an inexpensive little handbook on electrical engineering this has few equals. While it is an English book and written from the English standpoint the fundamental data applies equally well in this country. The present edition contains essentially the same material that was contained in previous recent editions but new sections dealing with electrical methods of measuring temperature and electric braking have been added. New matter is also included on single phasing of induction motors, and on 3 phase commutator motors. In general, the book covers the entire broad field of electrical engineering. It includes many tables and has an excellent index.

The Measurement of Alternating Current Energy. By Donald T. Canfield. First edition. 210 pp., 5½ by 8 in., illustrated, cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1940. Price $2.00.

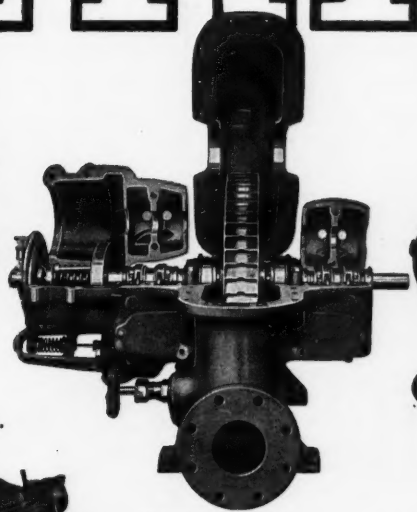
This book answers the basic and fundamental question, "What makes the disc go 'round?" It deals exclusively with the measurement of alternating current energy and hence with the induction watt-hour meter and its application. The author is Associate Professor of Electrical Engineering at Purdue University. As he points out in the preface, for the past 15 years he has kept a more or less complete record of the questions asked by metermen in this country concerning their vocation. The most frequently repeated question has to do with the use of vectors. As a result and largely as an experiment he published in 1931 a small text entitled, "Vector Representation for Electrical Metermen." The reception of that book gave definite proof of a real need in this field for texts that these men could use and understand.

This book is intended to act as a companion volume to the former. It attempts to answer not only the question, "What makes the disc go 'round?" but also the following: How can the revolving disc be made to measure energy? What metering scheme should one use to measure energy in a particular circuit? How may one be sure that all the energy in such a circuit is metered by the particular scheme chosen? There is a full discussion of the meter constants and ratios and the last part of the book shows the development and application of a method of proving the correctness of any proposed metering combination.

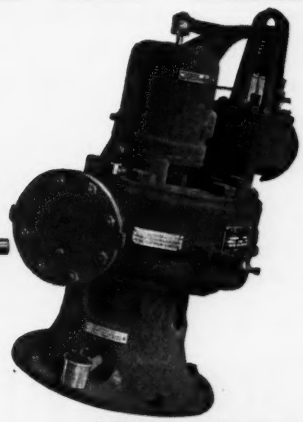
TERRY



SINGLE STAGE
AXIAL FLOW,
THREE ROW WHEEL.

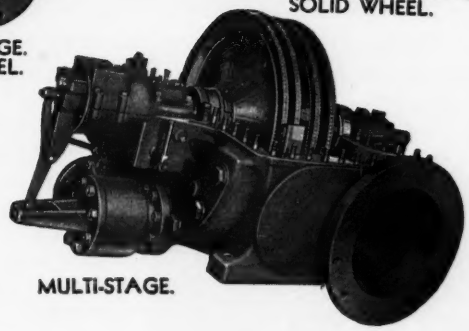


SINGLE STAGE.
SOLID WHEEL.



VERTICAL SINGLE STAGE
SOLID WHEEL.

MULTI-STAGE.
OIL RELAY GOVERNOR.



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Electrical Distribution Fundamentals. By Frank Sanford. First Edition. 242 pp., illustrated. 6 by 9 in., cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1940. Price $2.50.

Written from a non-engineering viewpoint, this book gives the perspective, development and economic background of electric distribution as a part of the general system of electric supply. The book is intended primarily for the men on the job, both in electric distribution divisions of the utilities and in the industrial wiring and commercial contracting branches of the broad field of distribution to the outlet. The author is Distribution Engineer at the Cincinnati Gas and Electric Co. Graphical methods of solution are used for typical problems of line design. Essential theory is explained largely by means of comparison and analogy. Reference to formulas based on trigonometry, calculus, etc., is avoided. There are included, however, many problems that require a working knowledge of voltage drop, wire size calculation, transformer connections, inductive reactance, power factor, etc. Emphasis is given to the everyday problems and their relation to the standards and practices that have followed many operating and economic comparisons in past developments.

An Air-Conditioning Primer. By William Hull Stangle. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. Size 6 by 9 in., 236 pages. Price $2.50.

This book presents the simple fundamentals and essentials of air conditioning in non-technical language. It is divided into two parts, Part I covering the basic characteristics of heat, air, people and houses. Application and apparatus comprising the practical adaptation of the fundamentals of Part I are covered in Part II. Necessary tables and charts are given in the Appendix.

Induction Motors. By S. Gordon Monk. First Edition, 126 pages, 6 by 9 in. Cloth. Chemical Publishing Co., 148 Lafayette St., New York, N. Y. 1939. Price $2.00.

This little book presents a general survey of the properties and applications of the induction motor. As pointed out by the author in the preface, it is not intended to be exhaustive and the design elements of the subject have been touched upon only lightly. Design, he says, involves far more space than was available and besides it is not a very well-defined subject. Many factors are capable of variation and manufacturing methods are continually changing. The fundamental principles and properties, however, remain and it is the exposition of these that is the main concern of this work.

The author is head of the Electrical Engineering Department at Plymouth and Davenport Technical College in England. Numerous examples are presented and the answers to these are listed in the back part of the book. The chapter headings are as follows: 1. Introduction—Fundamental Principles. 2. Torque properties. 3. Testing and equivalent circuit. 4. The circle diagram. 5. The single phase motor. 6. The synchronous induction motor. 7. Methods of starting induction motors. 8. Speed control of induction motors. 9. Improvement of power factor of induction motors. 10. Design of induction motors.

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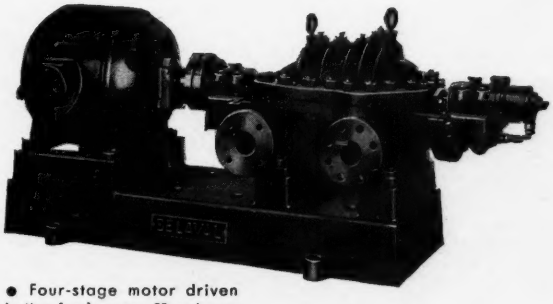

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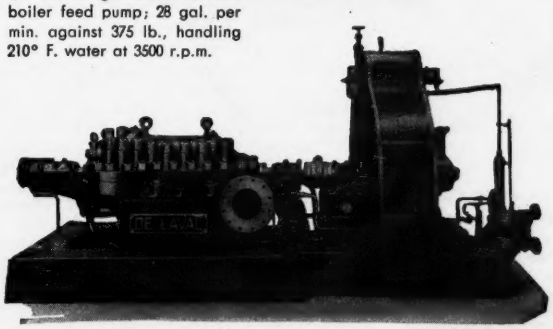

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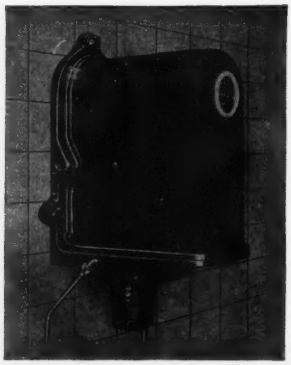

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Introduction to Electrical Machines. By A. W. Hirst. First Edition. 122 pages. 5½ by 8½ in., cloth. Chemical Publishing Co., Inc., 148 Lafayette St., New York, N. Y. 1940. Price $2.25.

A concise and up-to-date textbook suitable both for electrical engineers and for students at universities and colleges. It contains, (a) a certain amount of descriptive matter on magnetic and insulating materials, the general construction of the electromagnetic machine, and a discussion of the losses, temperature rise and ventilation, and (b) a discussion of certain subjects which usually present difficulties to students and to which too little space is devoted in many textbooks. The subjects covered, as listed in the contents, are as follows: Fundamental principles and relationships; The magnetic circuit and magnetic calculations. The electromagnetic machine. Insulation and insulating materials. Losses—heating and ventilating of machines. Wave form and harmonic analysis.

Electric Wiring, Theory and Practice. By W. S. Ibbetson. Sixth Edition. 264 pp., illustrated, 5 by 7¼ in., cloth. Chemical Publishing Co., 148 Lafayette St., New York, N. Y. 1940. Price $2.50.

This is a standard book on electrical installation work; the aim of the author throughout has been to make the principles underlying the theory and practice of electric wiring as clear as possible. Although an English book, the treatment is such that American readers will have no difficulty in applying the principles discussed to wiring methods and equipment in this country. The book contains a large number of problems both theoretical and practical, illustrated and worked out in detail. There are special chapters dealing with motors and generators. The subjects listed in the contents are as follows: General principles; resistance, Ohm's Law applied to A.C. and D.C. circuits; distribution of power; instruments: accessories; fuses, switches, etc.; wiring systems; two-way and intermediate switching; insulators and cables; soldering, etc.; testing installations, fault finding, illumination, design, lamps, batteries and bells, dynamos and small generating plants, A.C. and D.C. motors, tables, index.

A.S.T.M. Standards, 1939. Published by the American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa. Published in three parts; prices and contents given below.

Important changes are incorporated in the latest edition of this A.S.T.M. publication. For the first time it contains all of the Society's specifications, both standard and tentative. Formerly the tentative specifications were issued in an annual volume, but the convenience of having these and the formally adopted standards in one volume led to the present combination. In its present form the book of standards will be published every three years, with extensive supplements to keep the book up to date published in 1940 and 1941. The book is in three parts as follows:

Part I. 1335 pp., includes 298 specifications, tests and definitions of ferrous and non-ferrous metals. In the ferrous metals are included all structural and rivet steels, boiler plates, tubes and pipe, wrought iron, pig iron, ferroalloys, etc. The non-ferrous group includes aluminum, magnesium, copper, lead, nickel and zinc alloys, bearing

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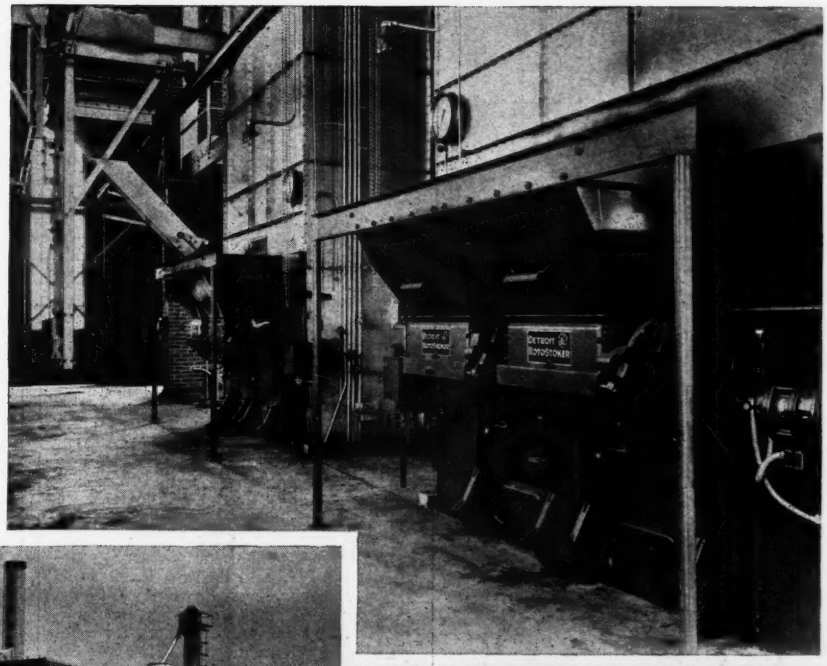

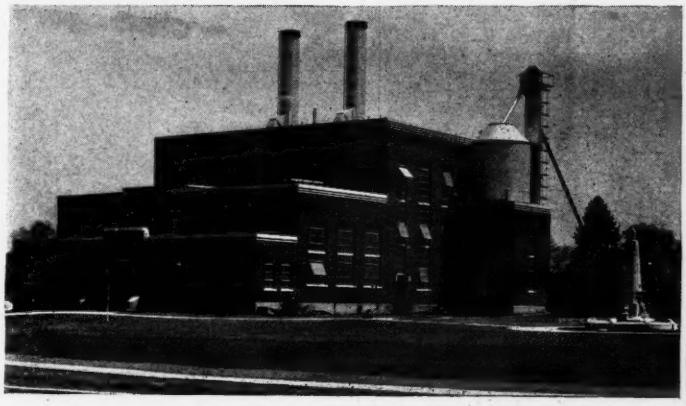

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G. H. Palmes, City Manager • A. L. Evans, Electrical Engineer

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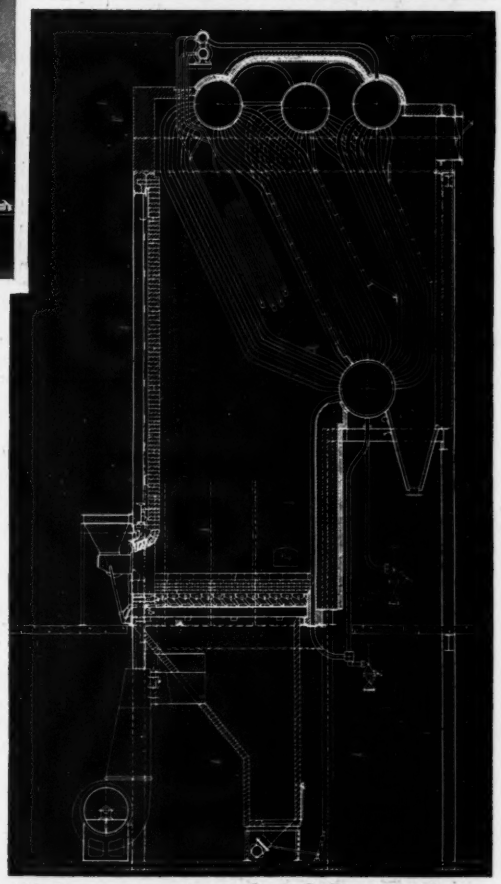

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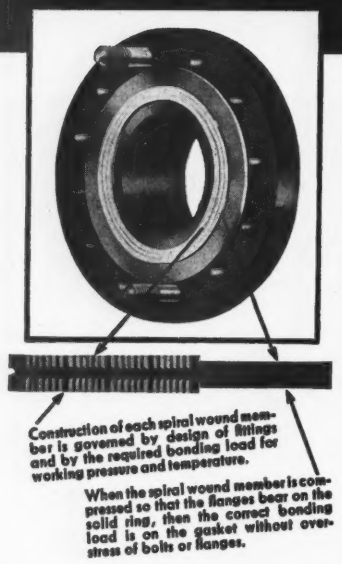
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Part III, 1203 pp., includes 245 specifications, tests and definitions in the general nonmetallic materials, including coal and coke, petroleum products and lubricants, electrical insulating materials, plastics, rubber products, textile material, paper, soap, naval stores, water, etc.

Each part contains a complete separate index with three tables of contents, the first listing items under general materials covered, the second giving a complete list of all items by numeric sequence and the third the tentative standards by subject. Pending formal adoption these tentative standards are widely used by industry.

Prices, in cloth binding, are $8.00 for one part, $16.00 for any two parts, and $22.00 for all three parts. Supplements for 1940 and 1941 are $3.00, $5.00 and $7.00 per year respectively for one, two or three parts. Half leather binding is $1.00 per volume extra for each part or supplement.

Procedure Handbook of Arc Welding Design and Practice. Sixth Edition. 1118 pages, 5¾ by 9 in. Dark blue semiflexible simulated leather cover. Published by The Lincoln Electric Co., Cleveland, O. 1940. Price postpaid in the U. S. A., $1.50. Outside U. S. A., $2.00.

In its sixth edition this handbook is more complete and more valuable than ever. Encyclopedic in scope, concisely written and well illustrated it is a complete arc welding reference guide. It is written for use by designers, engineers, architects, production managers, welding supervisors and operators and it contains a wealth of information of interest to engineers, designers, architects, draftsmen, steel fabricators, cost estimators, piping and pipe line contractors. This edition follows the same general style of the previous editions but has been brought up to date to include the latest developments in the art of welding. It is as complete a treatise on arc welding as could be found anywhere. It has an excellent index and its low cost is an attractive feature.

Methods of Measuring Radio Noise, 1940. A report of the Joint Coordination Committee on Radio Reception of E.E.I., N.E.M.A. and R.M.A. 10 pages. E.E.I. Publication No. G9. Edison Electric Institute. 420 Lexington Ave., New York, N. Y. Price 20 cents to members and their employees, 50 cents to non-members in U. S. A., 60 cents to foreign countries.

This report contains the recommendations of the Committee as to the nature, essential characteristics and performance of a meter for the measurement of radio noise. It further gives detailed descriptions of recommended practices in the use of the meter for measuring directly, radio noise from low and high voltage apparatus, for making radio noise measurements along overhead lines, for determining broadcast field strength and for collecting data for the establishment of radio noise standards.

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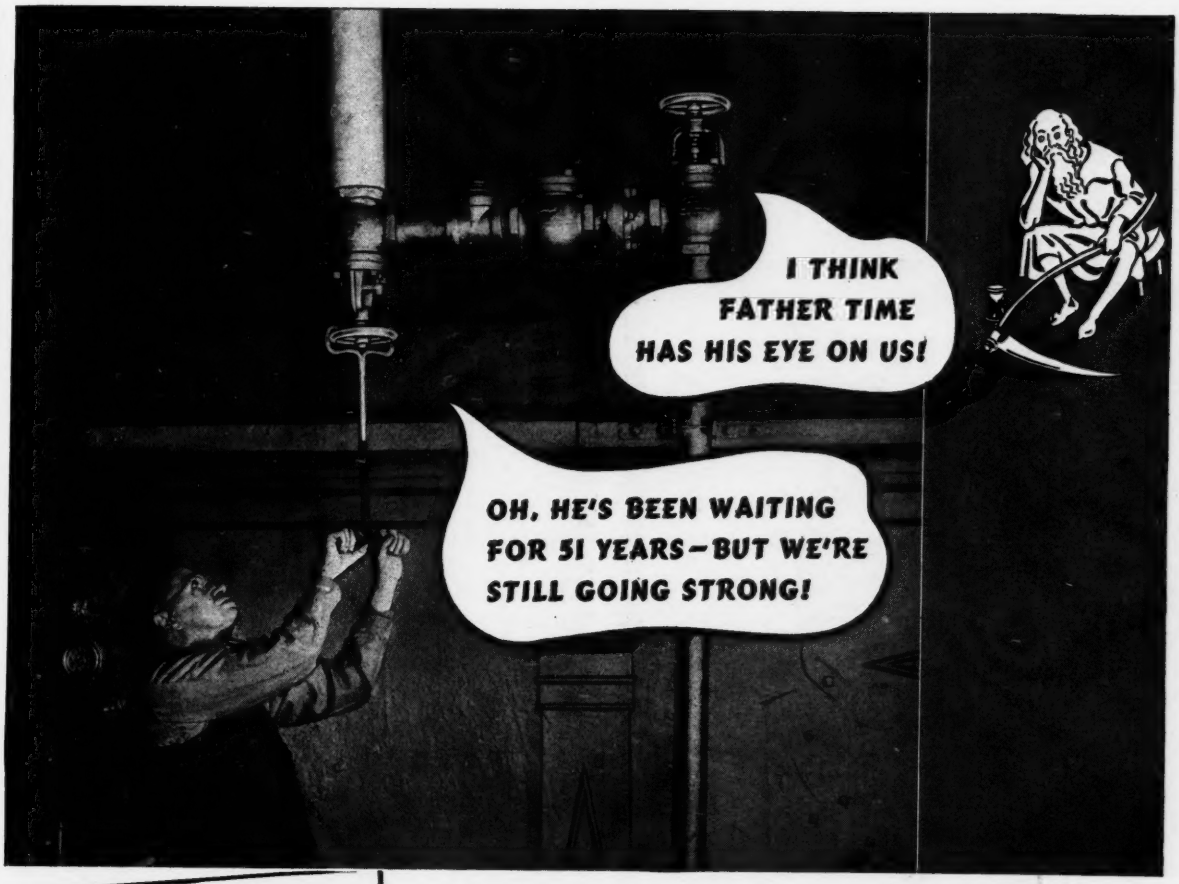
If you read the advertisements of such concerns, which are found regularly in POWER PLANT ENGINEERING, and study their messages, you can be confident of buying trustworthy power plant machinery and equipment from these progressive advertisers.

By taking full advantage, too, of the valuable installation and operation information given in the many new catalogs and special bulletins issued by manufacturers, you will gain greatly in up-to-date knowledge.

Let us know if we can help you solve any perplexing operation problems which come up in your daily work; or if you would like us to secure catalogs or data for you on any particular type of power equipment.

Address the Reader Service Department, POWER PLANT ENGINEERING. There is no charge, of course, for this service.

★ ★



"COST-PER-YEAR" of these Jenkins Iron Valves

Fig. 143 (2) and Fig. 151

Initial Cost *(3 Valves)* . .	$25.48
+	
Annual maintenance . . .	$.40
÷	
Years of Service	51
=	
Cost-per-year (per valve) . . .	$.17

and they're still going strong!

HERE'S an economy picture that any P.A. would like to have in his plant. They are Jenkins Iron Body Valves and belong to the Public Service Co. of Colorado, Denver—serving boiler feed line on steam heating plant.

Angle Valve at the left has been opened and closed once an hour, 9 months of every year since it was installed in 1889. And they're still going strong! The only maintenance in this severe service has been a disc replacement about once a year.

Chief Engineer A.W. Ridley (shown) who actually made this installation 51 years ago, confirmed the age of the valves and offers the opinion that they are good for many more years of service.

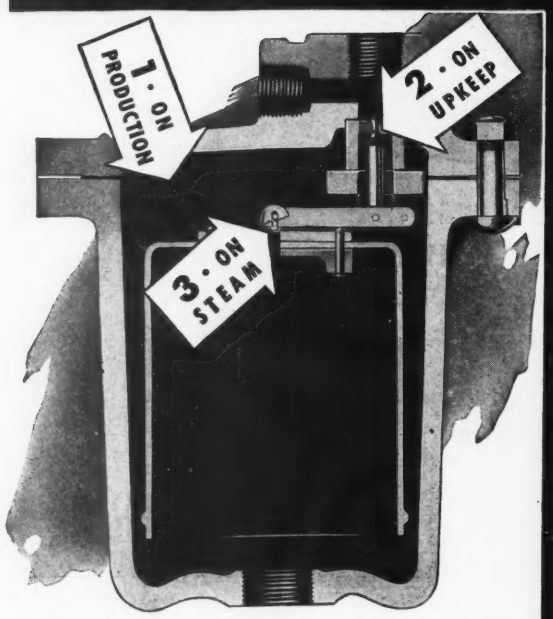
So many low-cost service records like this have been uncovered recently that it's no wonder buyers are saying "Jenkins Iron Valves are our best buy".

JENKINS BROS., 80 White St., New York, N.Y.; Bridgeport, Conn.; Boston; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas Montreal, Canada London, England

IN VALVES *Jenkins* GIVES YOU EVERYTHING

PIPEWRENCH PETE SAYS:

THESE 3 SAVINGS MAKE SENSE TO ME!



1 Cut down spoilage, keep production UP! Strong's positive-acting, extra-capacity traps often increase output amazingly — always keep costs DOWN!

★ ★ ★

2 Strong traps just don't seem to wear out! That special, wear-resisting Anumetl makes STRONG valves and seats last eight times as long as even Strong's former parts. You get a full year's guarantee against valve leakage or any replacement.

★ ★ ★

3 How much can positive opening and tight closing of your traps save on steam? Get these savings with STRONG'S *anti-balancing* device! Valve opens wide to discharge condensate, then closes tight—no dribbling! Positive action, plus Anumetl valves and seats can easily save more than the trap costs, in steam alone.

★ ★ ★

MONEY-BACK GUARANTEE! Test Strong traps on your toughest jobs. If not satisfied at the end of 90 days, return them, and your money will be refunded.

HOW DO YOU SIZE STEAM TRAPS? An easy method, plus valuable information on installations, etc. Get Catalog 63-PE2

THE STRONG, CARLISLE & HAMMOND CO.
1392 WEST THIRD ST., CLEVELAND, OHIO

STRONG
STEAM TRAPS

Air Conditioning Rockefeller Center

TWO large refrigerating machines are being installed in the sub-basement of the RCA Building in New York City and will give Rockefeller Center the world's largest air-conditioning system for human comfort in a commercial development. Each of the machines weighs 32 tons and has a refrigerating capacity of 900 tons.

The new units will serve the RCA Building, the RCA Building West, the Time & Life Building, Ten Rockefeller Plaza, and the United States Rubber Company Building. A sixty-foot tunnel, seven feet square, has been blasted under Forty-ninth Street to connect the plant with buildings in the southern part of the Center.

Six other plants in the Development completely air-conditioned the British Empire Building, La Maison Francaise, the Radio City Music Hall, the Center Theatre, the NBC section of the RCA Building, and supply conditioned air to the shops and many offices in the International Building and the Associated Press Building. With the new units, these plants will have the same cooling effect in twenty-four hours as 6,800 tons of melting ice. Water used to extract the heat from the refrigerating machines is pumped to cooling towers on the roofs of buildings in the Center.

Present plans call for future additions to the systems to keep pace with the demand for conditioned air. Clyde R. Place is the consulting engineer.

Advancing Boiler Pressure

FOR A NUMBER of years, The Engineering Foundation, the American Society of Mechanical Engineers, Purdue University, and numerous contributors have been sponsoring research work in the field of critical steam pressures. Dean A. A. Potter of Purdue University, who is chairman of the special research committee working on the problem, has recently reported the progress that has been made and the present status of the investigation. In the following paragraphs taken from his report, it will be noted that the investigators continuously find need for fundamental data that are not available, the compilation of which is delaying the final results of the project but has broadened the scope and the benefits to be derived as well.

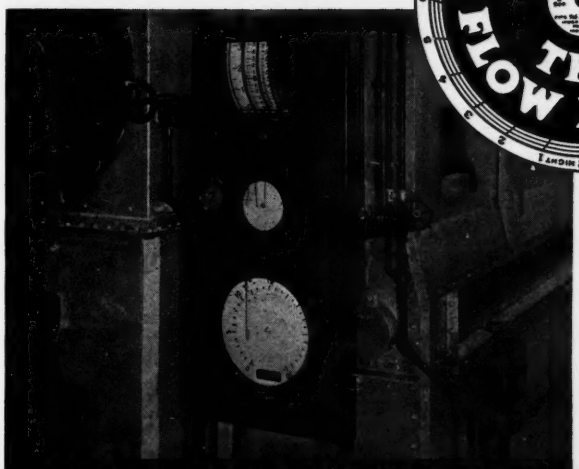
"Steam power economy has greatly benefited during the past 15 yr. by a marked increase in steam pressures and temperatures. Until 1924 no power plants were in operation at pressures in excess of 350 lb. and temperatures greater than 700 deg. F. One-third of the recently installed large prime movers were designed for pressures of 1200 to 1400 lb. per sq. in. and for temperatures of about 900 deg. F. Two units will shortly go into operation at pressures of 2200 to 2500 lb. per sq. in. and for temperatures of 900 to 950 deg. F.

Continued on Page 108

1 OBSCURE POSITION. *Where knowledge of daily flow is wanted for accounting or record purposes, the position of the instrument is relatively unimportant. It may be placed in an obscure position; an indicator is not necessary, but the recording chart will show the past 24 hours' operation and the integrator will permit determination of total flow for the period. Cochrane Publication No. 2081 gives a detailed description of such an installation.*

2 DEPARTMENT OFFICE. *Where the engineer or superintendent may want to know at any time of the day at what load the department or process may be operating. Locating the meter in his office or close by makes it possible for him to keep a watchful eye on this factor while performing other work. A description of this type of meter is contained in Cochrane Publication No. 2096.*

WHERE TO LOCATE THE FLOW METER



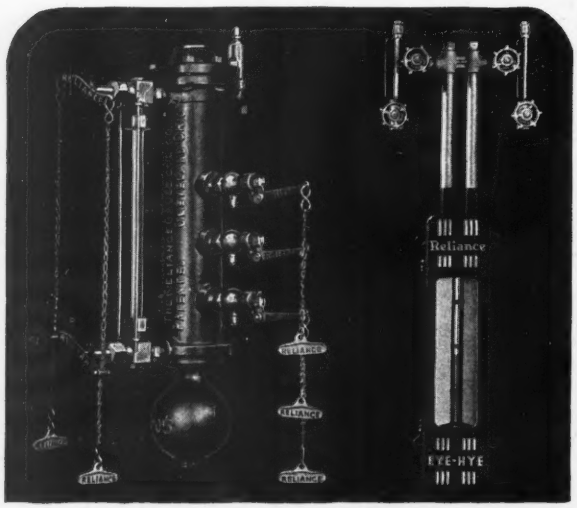
3 NEAR THE SCENE OF ACTIVITY. *Where the flow meter may assist operators in planning or controlling the apparatus or process upon which they are working, the flow meter should be located as close to the scene of activity as possible. A large, easily read indicator is advisable, and the recording chart will help him visualize trends, while the integrator will show total flow. Cochrane Publication No. 2094 on Mechanical Flow Meters gives detailed information.*

4 CENTRALIZED MEASUREMENT. *Where proper knowledge of the factors influencing operation may be had only by use of related instruments, the flow meters should be grouped with such instruments on a central panel. Typical examples are the control of processes, a group of boilers or departmental loads, where in each case maintenance of highest efficiency is best assured by being able to picture at a glance the relative condition prevailing. Cochrane Publication No. 2096 shows many examples of such panels.*

COCHRANE CORPORATION • 3123 N. 17th St., Philadelphia, Pa.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • HOT WELL EQUIPMENT • VALVES • FLOW METERS



Get the Most

Out of your Power Dollars

The Reliance Safety Team helps you avoid time-and-money-wasting power breaks caused by water level accidents

The approved modern way to protect your valuable boiler investment is to have *double* water level reading facilities. Reliance ALARM and EYE-HYE supply an outstanding combination of *safety* and *convenience*—guard against any slighting of water level supervision that may result in lost production time and costly accidents.

The ALARM is your *sound* check—warns instantly by whistle when water level goes too low or too high. Extra sturdy, dependable, Reliance ALARMS are standard equipment with many boiler manufacturers.

EYE-HYE brings boiler gages to the operating floor —an easy frequent *sight* check. You can keep water at the most efficient level. Approved by engineers and government bureaus.

Achieve smoother power control and safety that relieves you of water level worries. Put the Reliance Safety Team on your staff and get the most out of your power dollars. Write today for illustrated bulletins.

The Reliance Gauge Column Company
5902 CARNEGIE AVENUE CLEVELAND, OHIO

Reliance
Boiler Safety Devices since 1884

"Since 1931 The Engineering Foundation has been most helpful to the Engineering Experiment Station of Purdue University in a study of steam generation at high pressures and temperatures. This investigation is under the immediate direction of the Special A. S. M. E. Research Committee on Critical Pressure Steam Boilers.

"The first portion of this investigation was concerned with a study of the characteristics of the once-through, or forced flow, steam generator at pressures of 1500 to 3500 lb. per sq. in. and at temperatures up to 830 deg. F., and including automatic control for such steam generators.

"This was followed by an investigation of flow distribution at pressures of 1500 to 3500 lb. per sq. in. through parallel circuits consisting of various combinations of economizer, evaporating and superheating surfaces. This investigation has disclosed an absolute lack of accurate data on the viscosity of water and of superheated steam at high pressures and temperatures. Thus, two sets of researches by two different methods were undertaken, which have resulted in accurate values for the viscosity of water up to the critical temperature and for the viscosity of superheated steam at pressures up to 3500 lb. per sq. in. and 1000 deg. F.

"The investigation at present under way, which has gone on continuously for over 3 yr. has been concerned with a study of oxidation of metals when exposed to high temperature steam at temperatures up to 1100 deg. F. While this investigation is still incomplete, the results up to date indicate that certain alloys of steel will develop a coating of oxidation products which will protect the metal from rapid corrosion. Tests are now under way on 20 different alloys at a temperature of 1100 deg. F., and for periods of 500 to 2000 hr.

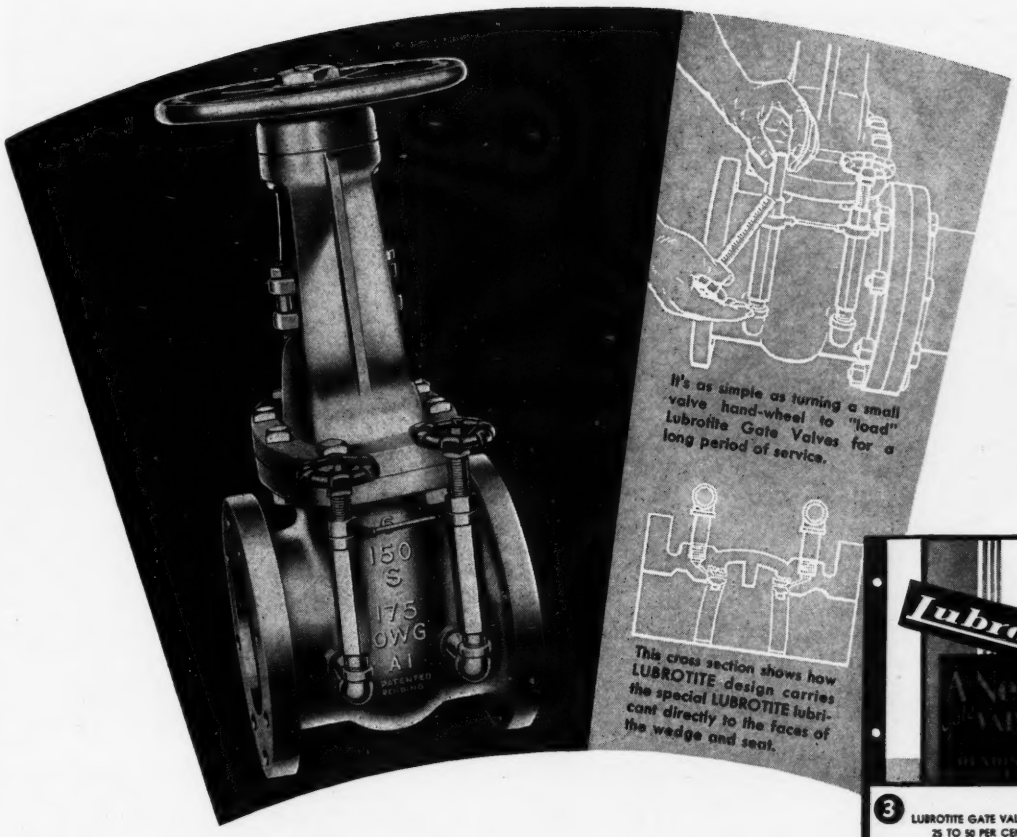
"The above investigations at Purdue University, which have received encouragement and financial support from The Engineering Foundation, have revealed new knowledge about forced-flow, high-pressure boilers; have resulted in new and accurate data on the viscosity of water and of steam at high pressures and temperatures, constants of value to builders of steam turbines, heat exchange equipment and piping systems; and will in the near future release information about the oxidation resistance of alloy steels suitable for high-temperature steam, knowledge of great importance to builders and users of steam generating equipment."

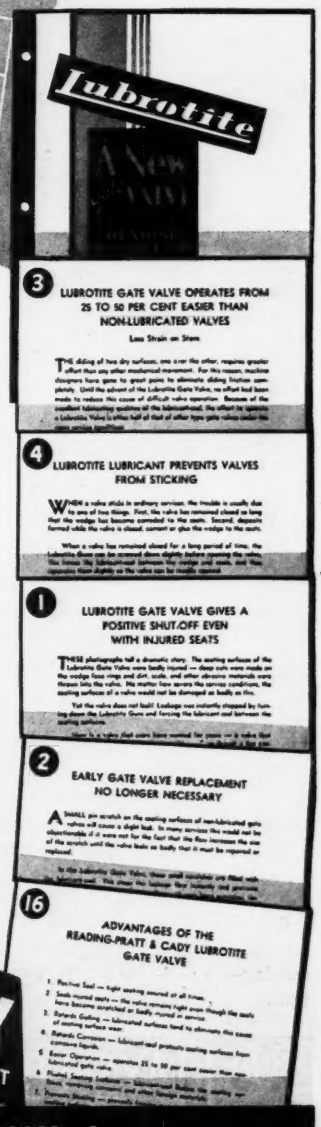
Fan Specifications Standardized

BY ADOPTING a program of standardization recently the National Association of Fan Manufacturers, brings the advantages of industry standardization to all users of fans as they may be applied by architects and engineers, or as they may be individually purchased.

In the past each individual manufacturer has set up his own standards, and as a result the industry has developed considerable confusion, in number of

(Continued on Page 110)


150
S
175
OWG
A1
It's as simple as turning a small valve hand-wheel to "load" Lubrotite Gate Valves for a long period of service.
This cross section shows how LUBROTITE design carries the special LUBROTITE lubricant directly to the faces of the wedge and seat.


Lubrotite
3 LUBROTITE GATE VALVE OPERATES FROM 25 TO 50 PER CENT EASIER THAN NON-LUBRICATED VALVES
4 LUBROTITE LUBRICANT PREVENTS VALVES FROM STICKING
1 LUBROTITE GATE VALVE GIVES A POSITIVE SHUT-OFF EVEN WITH INJURED SEATS
2 EARLY GATE VALVE REPLACEMENT NO LONGER NECESSARY
16 ADVANTAGES OF THE READING-PRATT & CADY LUBROTITE GATE VALVE

IF GATE VALVE MAINTENANCE IS HIGH TRY *Lubrotite* GATE VALVES

With Reading-Pratt & Cady Lubrotite Gate Valves in your line, an occasional short turn of the LUBROTITE hand wheel makes certain a tight seat, protects seat and wedge from corrosion, prevents jamming or sticking—even provides a tight seat in valves so old that natural wear has deeply scarred the faces of wedge and seat.

If your gate valve maintenance is high, get our recommendations for using LUBROTITE Gate Valves—the Reading-Pratt & Cady Gate Valve *plus* LUBROTITE.

Get a copy of this well illustrated 16-page Lubrotite booklet

There's not too much to read in this 8½ x 11, 16-page booklet. Pictures do most of the talking—show conditions that LUBROTITE Gate Valves prevent and overcome—show the easily understood principles that govern LUBROTITE operation—indicate where LUBROTITE Gate Valves save you money. Write Reading-Pratt & Cady, Bridgeport, Connecticut, for your copy.

READING-PRATT & CADY

READING-PRATT & CADY DIVISION · BRIDGEPORT · CONNECTICUT

AMERICAN CHAIN & CABLE COMPANY, Inc.

THE ABOVE, well expresses the capabilities of the Hays Slack Leather diaphragm draft measuring unit—able to withstand tremendous pressure or suction, yet so sensitive it can measure increments of only .0025 of an inch water.

Hays pioneered the dry type of draft gage which today is still considered the standard for accuracy, versatility and long life. There are many styles with which to meet the differing requirements of the modern power plant, to be mounted either separately or with other instruments and control units on a panel.

Hays diaphragm type draft units are so compact that as many as 24 have been mounted in a single case. A five unit gage is shown above at the left.

There is a Hays representative near you. . . .

Write to HAYS at 910 Eighth Avenue, Michigan City, Indiana, for specification literature and catalog—no obligation.

THE HAYS CORPORATION
SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

sizes and interval between sizes. The final program of standardization presented at the Annual Meeting of the Association held in Chicago, Illinois on April 11, 1940 included the following essential points:

1. The scope of standardization covers those types of centrifugal fans designed for application in, and furnished under specifications for, the heating, ventilating and air conditioning fields.

2. To serve the range of field applications, standards were established for 25 sizes of fans by setting up a series of maximum wheel diameters between the limits of 1 ft. to 11 ft. and their corresponding maximum outlet areas for both single width and double width types. The series was based on the preferred number system advocated by the American Standards Association. Individual design or patented features will be in no way restricted and the fan designers' opportunity for development of high efficiences remains ample.

The entire program of standardization was approved to become effective the early part of 1941.

Membership of the Association includes the following fan manufacturers: American Blower Corporation, Autovent Fan and Blower Company, Bayley Blower Company, Buffalo Forge Company, Clarage Fan Company, Garden City Fan Company, The Green Fuel Economizer Co., Inc., Ilg Electric Ventilating Company, The New York Blower Company and B. F. Sturtevant Company.

The Executive and the Technologist

AT A MEETING of the Society of Chemical Industry held in New York City on February 16, William B. Bell, President of the American Cyanamid Company, and Dr. E. C. Williams, Director of Research and Vice President of the Shell Development Company, expressed the following opinions in their talks on the subject "The Executive and the Technologist":

Modern industry looks for its future development not to the expansion of land frontiers or new sources of raw materials, but to the creation through research of new products from existing materials. It is well to consider not only in whose hands such potentialities for change lie and how competent those hands are to control them, but to what extent there is unity of outlook between them and the business executives. Complete understanding between top executives and research leaders is most necessary.

While there is a trend toward bringing technical men into leading executive positions, there will be an interim during which the more traditional type of executive and the research leader will have to make special effort to get together mentally. It would be too conservative to think that executives think only of money and that technical men are theoretical and impractical. The successful executive devotes much attention to understanding the basic processes of his industry and the research leader usually appreciates the problems and difficulties of executive control.

Continued on Page 112

FOR DEPENDABLE VALVE SERVICE • SPECIFY

POWELL VALVES

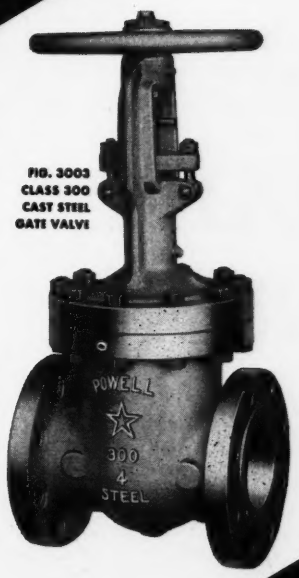


FIG. 3003
CLASS 300
CAST STEEL
GATE VALVE

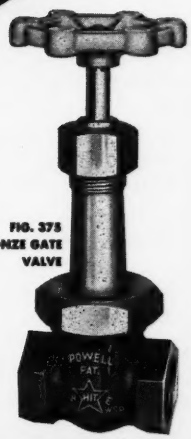


FIG. 375
BRONZE GATE
VALVE

FIG. 190
IRON BODY
GLOBE VALVE

LONG LIFE, ALL TYPES AND SIZES, EXACTING WORKMANSHIP

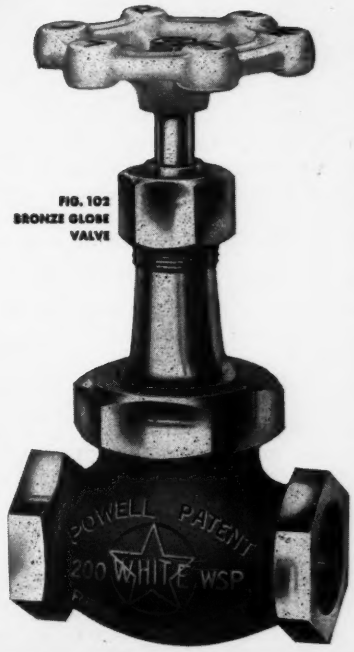


FIG. 102
BRONZE GLOBE
VALVE

FIG. 1460
IRON BODY
GATE VALVE

FIG. 1793
IRON BODY
GATE VALVE

WRITE FOR FURTHER INFORMATION AND DETAILS

THE WM. POWELL COMPANY
CINCINNATI, OHIO

What's The Trade-In Value of a

DART UNION?

WHAT'S a Dart worth after you've used it once? Unless it's been in service under exceptional conditions, chances are its "trade-in" or *used value* is practically the same as when new. In other words, you can put that same union back in service—reinstall it again and again—with full assurance of getting tight, dependable joints. . . . Come right down to it, that's the only real economy in pipe unions: *repeated use.* Darts give it to you with ground, bronze seats—full, wide true ball, precision seating surfaces—air refined malleable bodies and nuts. . . . Next time you change piping, make your dollars go further with Darts. Want to send for one to try, free?

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.

Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

There are, however, plenty of possibilities for misunderstanding arising from the different backgrounds of the executive and research type and the way they work. Possibilities exist of the prestige and authority of a top executive clouding true issues. In many cases, the expression of a belief by a sufficiently important executive tends to make that belief a fact. The greater he becomes, the greater will his beliefs tend to influence the facts. On the other hand, the beliefs of a scientist do not at any time have the slightest influence on the facts. This tends to breed skepticism in the scientist's mind for accepted beliefs as such and leads to misinterpretation by the executive that the scientist is reluctant to pull along like a decent fellow.

Three main pillars of modern technological industry are capital, science (or technology) and labor. If these three can be properly meshed by executive skill into a smoothly working whole, prosperity and safety alike are on a sound foundation. Science in industry is no dilettante occupation for dreamers but a revolutionary force which industrial executives should exert themselves to understand, go more than half way to meet and work to blend into the complex machine of industry. Any industry which neglects to take account of what is going on in the research laboratories is on the road to decay.

Contracts Affected By Coal Act

DIRECTOR Howard A. Gray of the Bituminous Coal Division, U. S. Department of the Interior, made a formal statement to the coal industry on May 16 in which he stated that the minimum prices soon to be established by the Division would apply to all contracts for the sale of coal except those which are exempt as lawful, bona fide written contracts made prior to June 16, 1933. This, the Director said, is a specific provision of the Bituminous Coal Act of 1937. The minimum prices will apply to all such contracts, even if the prices stipulated in them are lower than the minimum prices established under the Coal Act.

Minimum prices recommended by the Division Trial Examiners after extensive public hearings, now before Director Gray for decision, reflect increases over the actual prices at which many coals have been sold or are being sold. The Director, however, will not act until he has heard arguments on exceptions filed by interested parties who do not agree with the Trial Examiners' recommendations.

The general intent of the Coal Act is to stabilize the marketing of coal and raise the coal industry's income up to its cost level by the establishment of minimum prices and marketing rules. Congress found that price-cutting and certain trade practices it declared unfair had caused huge financial deficits in the industry for years, with severe social and economic consequences. Income tax figures show

(Continued on Page 114)

Practically as simple in Operation as

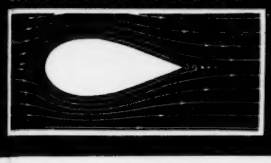
FLOW THROUGH A STRAIGHT PIPE

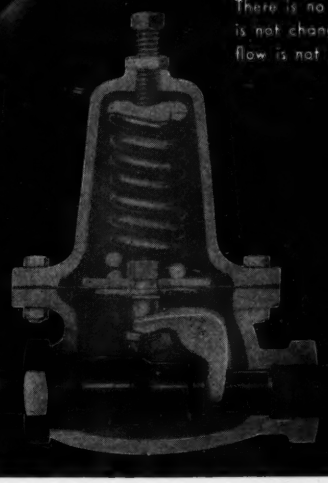
STREAMLINED

The Straight Line Flow eliminates turbulence, giving highest valve capacity. From inlet to outlet the fluid flows through this valve in a straight line—a streamline—almost as though there were a pipe running through the valve housing for the fluid to flow through. There is no detour around a dividing wall—the direction of flow is not changed at right angles because of a seat wall—also, the flow is not broken up by valve stems, springs, or other parts.

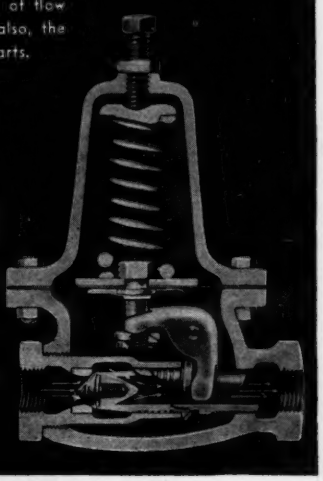
THE VALVE INCREASES PERFORMANCE RESULTS — BY ELIMINATING ORDINARY VALVE TURBULENCE LIKE THIS

. . . AND GIVING YOU STREAMLINED FLOW LIKE THIS





THE INNER VALVE FITS RIGHT IN THE LINE AS THOUGH A PART OF IT



WHAT THE *Streamlined* FLOW MEANS TO YOU . . .

Because of the Streamlined Flow—and No Turbulence, you are easily able to meet peak demand and yet hold the reduced pressure constant at the same time. Supply line pressure may change; demand may change—you still have smooth action, close dependable regulation. You experience no spoilage results due to erratic pressure—because the reduced pressure never varies.

What Some Users Say

Installed three years ago—
No one has ever touched them—
Mighty good—intend to buy more—

"It must be three years since we installed four or five of your Streamlined Regulators. The last I heard of them they were holding pressure the same as when we first installed them. And as far as I know, no one has ever touched them. They are mighty good; and we intend to buy more of them."
Case No. 345.

High capacity—
Accurate regulation—
Tight closure when not in use—

"I have telephoned our operating departments to ascertain why they have so persistently specified your '1000' Valves these past four years. All give me the same reasons: (a) the accuracy with which the Valves hold the pressure on the low side; (b) unusually high capacity; (c) ability to always close tightly when not in use."
Case No. 350.

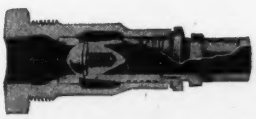
Simplicity—
No trouble from dirt—
Respond quickly—shut tight too—

"General simplicity. Have had too much trouble with pilot operated valves the moment that dirt comes along. Your Valves have no ports to gum up. They shut off tight too, and respond quickly whenever machines are cut in or cut out. I have listened to a lot of talk about dead-end but your Streamlined Valve is the first place I ever saw it. They have been shutting off perfectly and do not build up at all."
Case No. 352.

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVE

★ That the Streamlined (Type 1000) Valve stays on the job and gives you one cost saving benefit after the other is proved by statements from users such as those reproduced here. These users tell you exactly as we do, that you have no failures with the Type 1000, that you get longer service, that your dollars buy you more in production results, that you are easily able to meet peak demand and yet hold the pressure constant at the same time, and that over maximum service periods, maintenance expense is practically zero.

Now, Mr. Valve User, here's why you can experience exactly the same results—there are no complicated parts to get out of order—no small ports or passages to clog up—the rugged construction is obtained with fewest possible working parts—there are no close fits—and remember, there is straight line flow all the way.



The high pressure entirely confined to the small inlet chamber (cross hatched section) makes this valve good for initial pressures up to 3000 lbs. For delivery pressures below atmosphere a special diaphragm spring arrangement is used.

You may select a CASH STANDARD Streamlined Valve exactly suited for your service conditions. Bulletin 1000 shows how. Any combination of metals can be obtained for body, trim, valve seat, and seat ring. Handwheels for quick pressure adjustment also available.

Steam, air, water Capacity Charts for all Streamlined Type 1000 Valves

These charts in Bulletin 1000 are easy to use. They enable you to determine precisely how much fluid any size Streamlined Valve will deliver under your exact pressure conditions—for Steam, Air (and other gases), Water (and other liquids).

Free TRIAL

Try this Valve in your plant. No red tape. Just say "Ship on 30 days' free trial." After 30 days we send you a bill. You pay it; or you return the Valve at our expense. No strings attached. You are the sole judge. Why not order one Valve on trial—today?

SEND FOR BULLETIN 1000

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

TAKE A NOTE TO THE BOSS—OUR RECORDS SHOW FAIRBANKS VALVES GIVE THE BEST SERVICE AND COST LESS FOR MAINTENANCE, SO . . .
CHIEF ENGINEER

You, too, will agree that Fairbanks are *quality* valves if you give them a trial.

Their extensive use is conclusive proof of their satisfactory performance, long life and low maintenance cost . . . evidence that they assure easy and quick operation, positive shut-off and easy renewal. They give the greatest resistance to wire-drawing, corrosion and erosion.

Castings are carefully tested to make sure that there are no imperfections. All parts are gaged to insure a perfect fit. And after assembly every valve is subjected to the most severe test.

Made in standard and renewable types —for pressures from 125 lbs. to 350 lbs. —there is a Fairbanks Valve to meet almost every specific requirement.

We'll send you a Fairbanks Valve on trial. If you are not satisfied return it in 30 days and we'll make no charge.

Write today stating size and type desired and also ask for catalog No. 21.

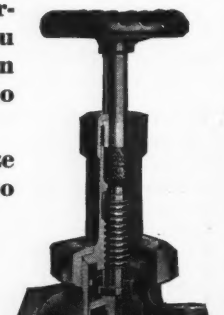


Fig. U-01
150 lbs. steam pressure

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***Standard and Renewable* Valves**

that the coal industry has not received its cost of doing business from the prices at which it has been selling its coal for any year since 1927.

A great deal of the country's coal production ordinarily is sold under contracts covering varying periods of time which specify certain coal prices. In order to make the Coal Act effective in stabilizing coal prices, Congress provided that the minimum prices should cover all coal sales transactions under jurisdicton of the law except where bona fide contracts had been made by the industry prior to the first time the government attempted to regulate the coal industry.

Producers of substantially all of the country's coal are participating in the stabilization plan under which the Division now is establishing minimum prices. Under the Coal Act, they may sell their coal at prices above the minimums. However, they cannot charge less than the established minimums, except under contracts made prior to June 16, 1933, without becoming liable to loss of "code membership," a 19½ per cent tax and suit for triple damages by injured "code member" competitors.

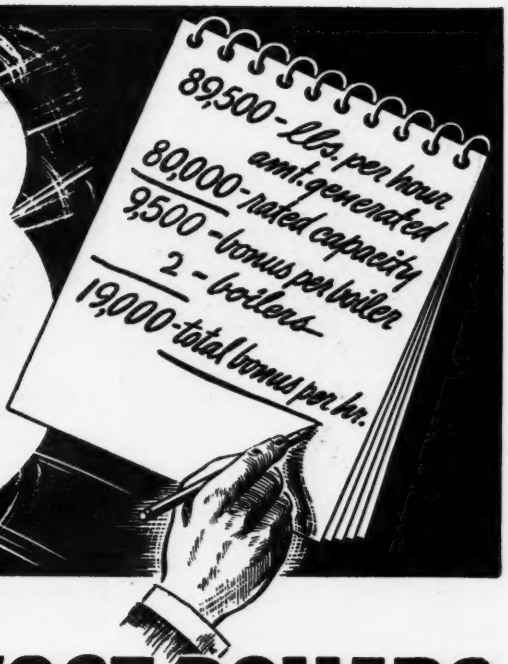
Technical Institutes Seek Recognition

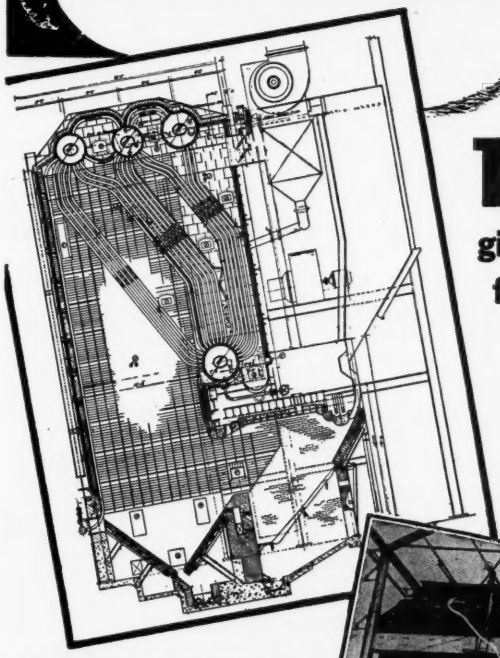
ALTHOUGH technical institutes and other non-degree technical programs in colleges are universally regarded as representing a necessary part of education for industry, it was claimed at a recent meeting in Pittsburgh by representatives from fourteen schools and institutes that the graduates of these courses are denied any recognition by civil service commissions, the state licensing boards for engineers, or the Engineers' Council for Professional Development. In line with this thought, the representatives of eleven of the institutions represented at the meeting authorized Parke R. Kolbe, president of Drexel Institute of Technology, to present the following petition to E.C.P.D.

"For many years leading authorities of the world of engineering education have emphasized the importance of the non-degree or technical institute engineering program. They have encouraged the establishment of these schools as filling a definite need for men of a training shorter and less theoretical than that given in the degree-granting engineering college. At the same time, nothing has ever been done to recognize, accredit, or legitimize the certificate granted by this type of institution. As a result, the graduates of these schools have found themselves, in many cases, at a definite disadvantage, since the training which they have secured receives little or no recognition from the engineering profession, as well as from many industrial employers who are naturally in doubt as to the meaning of the non-degree certificate. The representatives of the institutions here assembled do therefore petition the Engineers' Council for

Continued on Page 116

11½% STEAM BONUS





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give 19,000 extra lbs. of steam per hour for Newport Industries, Pensacola, Fla.

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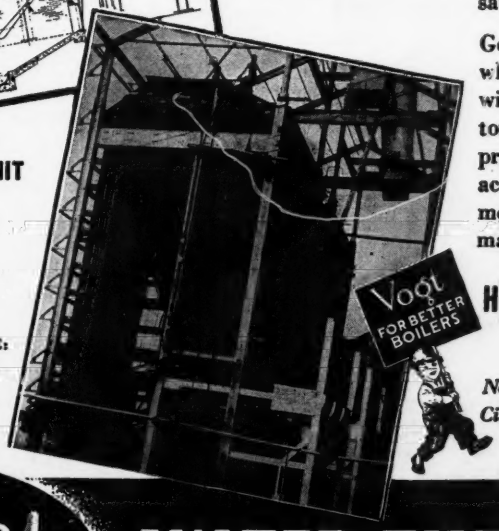
Get more for your steam dollars, whether expended for plant or fuel, with plus-value VOGT steam generators. There is a type and size, for any pressure and any fuel, which will exactly meet your operating requirements with lowest operating and maintenance expense.



PRINCIPAL DATA, EACH UNIT

HEATING SERVICE:
Boiler, 12,200 square feet
Water Walls, 520 square feet

CAPACITY:
80,000 pounds steam per hour

OPERATING PRESSURE:
160 pounds per square inch

DESIGN PRESSURE:
450 pounds per square inch

FEED WATER TEMPERATURE:
230 degrees F.

FUEL:
Spent Wood, 7720 B. T. U. as fired (20% moisture)
Natural Gas, 1015 B. T. U. per cubic foot

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Professional Development, through its Committee on Engineering Schools, or such other appropriate committee as it may appoint, to institute a study of the non-degree programs, both day and evening, now existing in this country, and to devise and propose such a plan of recognition or accrediting as may seem wise and just."

After consideration of the above petition at its April meeting, the Executive Committee of E.C.P.D. took steps to make a study of the petition and to report findings at the annual meeting to be held in Pittsburgh in October, 1940.

Coal Conference at Ann Arbor

IN Ann Arbor, Mich., on April 22, representatives of coal-consuming industries, fuel-burning equipment manufacturers, research organizations and retail coal merchants were guests of Appalachian Coals, Inc., Cincinnati, O., and the University of Michigan during the twenty-fifth fuel engineering conference sponsored by the A.C.I. marketing agency and the fourth annual coal utilization institute of the engineering college.

Registered attendance for this joint meeting amounted to 344, thus breaking the previous attendance record—326 persons attending the twenty-fourth fuel engineering conference in Kalamazoo, Mich.

J. E. Tobey, Cincinnati, O., vice president in charge of engineering for Appalachian Coals, Inc., who had arranged this conference and 24 others held since 1934, presided during today's sessions. Eight speakers contributed papers dealing with progress and trends in fuel utilization, varying fortunes of coal, trouble-shooting in industrial coal-burning plants, design of small industrial coal-burning plants, systematic coal selection, designing domestic furnaces, boilers and stoves, servicing domestic stokers, and the industrial history of bituminous coal. The engineering college and extension service of University of Michigan cooperated in the joint meeting by furnishing two speakers and providing facilities of the Michigan Union Building.

Progress in Fuel Utilization

"The past twenty years have witnessed many major developments in the production, preparation, and utilization of fuels that are worthy of analysis," stated Ralph A. Sherman, Columbus, O., supervisor, fuels division of Battelle Memorial Institute, in discussing progress and trends in utilization of fuel. He called particular attention to use of fuel for power and heat. After calling attention to steady progress in the increase in the overall efficiency of the utilization of fuel in central electric generating stations, the speaker stated, "Inasmuch as some central stations are operating with average efficiencies of close to 90 per cent from fuel to steam, the opportunities for further increases along this line are remote. Further advances must be made as they have been in the past few years by increase

(Continued on Page 120)

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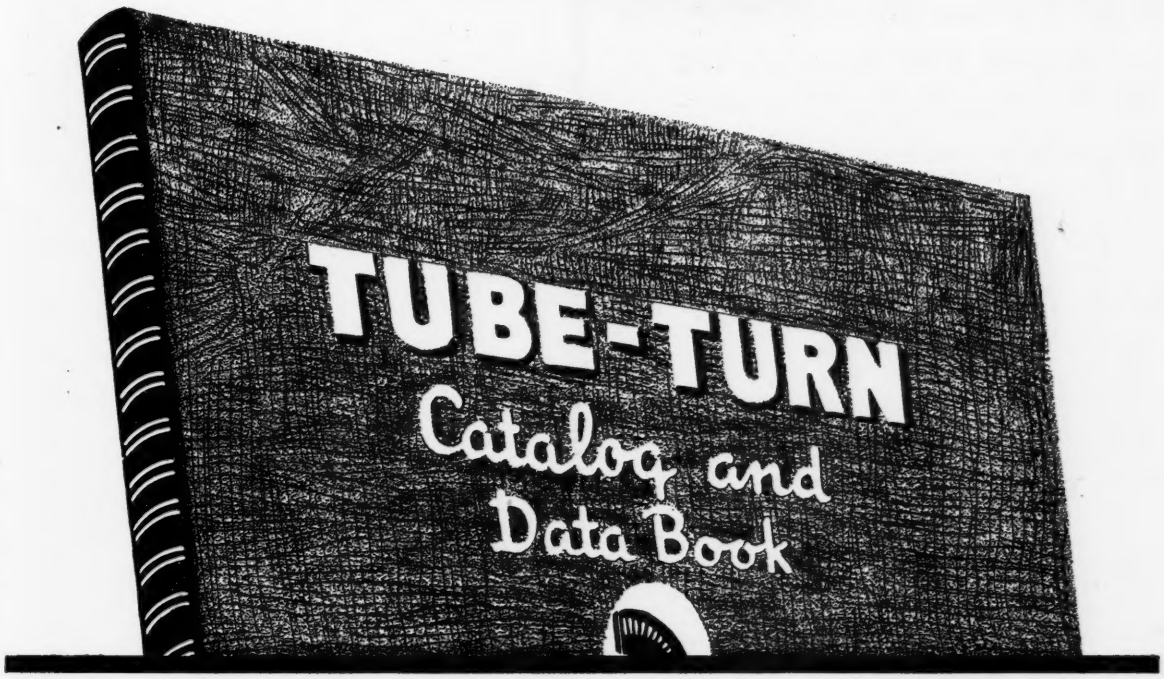

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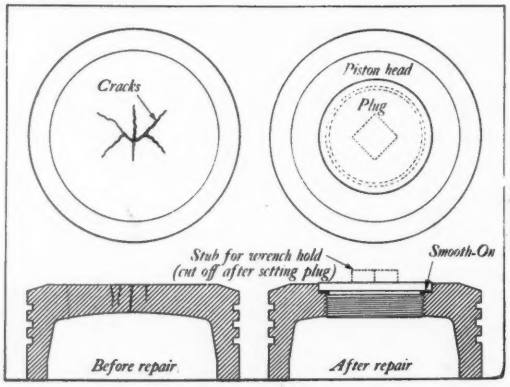

When the piston head of a Diesel or other internal combustion engine has been burnt or cracked from the extreme temperatures, the Smooth-On repair shown above will restore the initial strength of the piston and effect a large saving over the cost of a new piston.

The repair consists merely of boring out the weakened head metal and threading the bored hole. A plug is cast and threaded to fit the hole. By coating the threads and flange of the plug with Smooth-On No. 3 before screwing into the hole, a tight, pressure-proof fit is assured, because the soft metal of the Smooth-On No. 3 flows into and fills all voids. Any cracks in the piston head which may extend outside of the bored hole are filled with Smooth-On No. 1 which will make a pressure-tight seal. The stub, by means of which the plug is screwed into place, is cut off after the plug is set.

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in the efficiency of the steam cycle and by improvements in turbines." Sherman also discussed the present predominant position that pulverized coal has taken, improvements in underfeed stokers, advances in industrial plants, residential heating, stoves and hand-fired furnaces that will burn raw coal smokelessly, and research in coal. "The future for the profession of fuel engineering and research in coal," he concluded, "appears bright. The best performance of fuels today cannot be greatly improved, but too little of our fuel is being used at the best performance."

J. W. Parker, Detroit, vice president and chief engineer, The Detroit Edison Co. discussed the business of mining coal, drawing on experience gained from operating a captive mine in eastern Kentucky until 1934. Discussing the proportionate contributions of various fuels to total B.t.u. consumption, 1913 to 1938, Parker showed that 4 pounds of coal were used to produce 1 kilowatt hour of electricity in the early days; that this consumption has been reduced to less than 1 pound per kilowatt hour.

L. A. Shipman, Knoxville, Tenn., combustion engineer, Southern Coal & Coke Co., discussed his experiences in coal-burning industrial plants. "A fuel or combustion engineer," he said, "should never be a trouble-shooter." He urged that members of the power plant personnel should do the trouble-shooting in their respective plants. "Particle size, or bulk density, oxygen concentration, or air distribution, and the degrees of temperature rise, or burning rates," Shipman added, "are most important in combustion problems."

Shipman also called attention to some important work now under way by a joint committee of American Society of Mechanical Engineers and American Institute of Mining and Metallurgical Engineers to "determine the feasibility of formulating" a code for testing coal. "We hope," he added, "that an orderly method of observation can be compiled for our guidance in each method of burning."

Discussing the design of small industrial coal-burning plants, R. C. Porter, Ann Abor, instructor of mechanical engineering, University of Michigan, described a steam plant as "an interconnected and properly coordinated mass of equipment for converting the energy of fuel into energy of a more usable form." He advocated a study of the energy requirements (the load) and the nature and availability of the energy supply (the coal). He discussed loads, boilers, coal-burning equipment, furnace construction, boiler water conditioning, auxiliaries, steam piping, coal and ash handling, chimney and breeching, and controls and meters in detail, illustrating his thoughts with suitable slides.

Selection of Coal

"Systematic Coal Selection" was discussed by A. W. Thorson, Detroit, assistant fuel service engineer, The Chesapeake and Ohio Railway Co. "Selection of the proper fuel," he said, "is one of the vital engineering problems in industry. It has only re-

Continued on Page 122

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cently begun to receive the attention it deserves and even now is not widespread. American industry, pays an annual fuel bill in excess of 600 billion dollars. A large percentage of this fuel requirement is supplied by coal. In Michigan alone, some 20 million tons of bituminous coal per year are used to supply almost 80 per cent of the state's fuel needs.

Purchase by Planning

"The prime requisites of coal in an industrial plant," Thorson said, "are its ability to meet load demands, to produce maximum economy, to produce minimum of nuisance, and to provide a continuous and reliable fuel supply." He then suggested a detailed plan for making coal selection, listing the fundamentals; purchasing for large plants as well as small and semi-industrial plants.

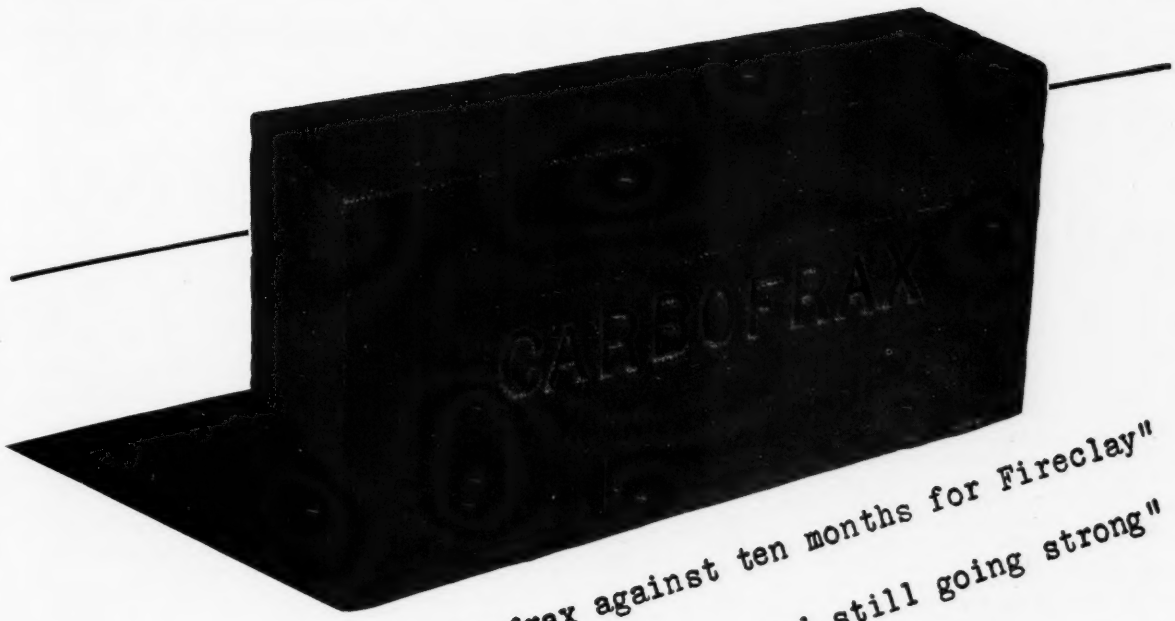
"It is important," he concluded, "that the management of each plant give consideration to a program of systematic coal selection, if for no other reason than to satisfy themselves that they are using the proper fuel. It is important also to repeat the process periodically. Plant conditions change; coal markets change; in other words, the job of fuel selection is never done. The economical and continuous operation of the power plant and consequently of the entire business it serves, depends upon the fuel supply. There is too much at stake to neglect this vital problem. The assistance of competent fuel engineers is available. Let us all do a real engineering job of selecting and purchasing our fuel requirements."

F. C. Calhoun, Ann Arbor, assistant professor of mechanical engineering, University of Michigan, called attention to "performance factors toward which improved design needs to be directed" in his paper on designing domestic boilers, furnaces and stoves.

Value of Coal Mined Exceeds that of Metal

Robert L. Rowan, Philadelphia, Pa., fuel engineer, General Coal, presented a paper on "Servicing Domestic Stoker Complaints" in which he stated ,"It is the duty of the stoker coal dealer not only to be in a position to help the consumer achieve maximum results but actually to render this service in a routine manner. There are a number of factors that determine whether a home is economically and satisfactorily heated: The fuel—heat source. The stoker —heat generator. The boiler or furnace—heat absorber. The piping or duct system—heat distributor. The radiators or registers—heat exchanger. The house itself—heat container, then dissipator."

The principal banquet speaker was Howard N. Eavenson, Pittsburgh, Pa., president, Clover Splint Coal Co., and a director of Appalachian Coals, Inc. He traced the early history of coal in the United States from 1679 and pointed out that "in 1919 the mine value of our coal exceeded for the first time that of all metals produced in this country, and it has remained in that place ever since.



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"Three times the life of fireclay and still going strong"

"Only 10 cents a year for Dollar Firebrick"

"Carbofrax outlasts Plastic Fireclay 13 to 1"

"Has lasted 1200% longer"

• The actual comments above are but a few of many such favorable expressions coming from industry.

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And because they remain clinker free, they assure full grate area at all times and eliminate the troublesome time-consuming job of cleaning walls.

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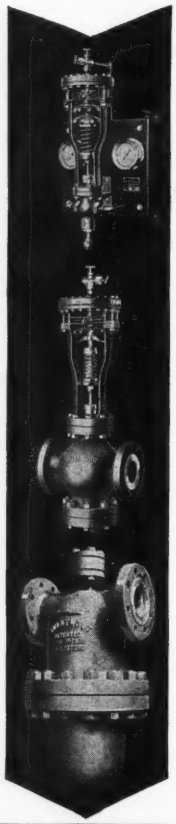

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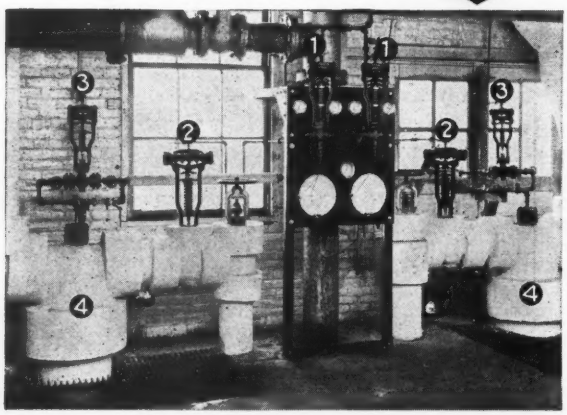

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Summer Meetings of A. S. M. E.

THIS year for the first time in its history The American Society of Mechanical Engineers, will hold the 1940 Semi-Annual Meeting in three cities at the same time. With simultaneous meetings taking place in Milwaukee, Wis., at the Hotel Pfister, June 17-20; in Ann Arbor, Mich., at the University of Michigan, June 20-21; and in Asbury Park, N. J., at the Berkeley-Carteret Hotel, June 19-22.

At the main meeting in Milwaukee 13 technical sessions will be held with 30 papers covering hydraulics, steam power, education and training, management, fuels, machine-shop practice, process industries, and railroads, several plant trips, luncheons, business meeting, and a banquet. The meeting at Ann Arbor, under the sponsorship of the Society's Applied Mechanics Division, will present four technical sessions, devoted to elasticity, dynamics, fluid mechanics, and thermodynamics, with 13 papers by some of the outstanding engineering theorists of the country. Besides an exhibit of Diesel engines and accessories, the A.S.M.E. Oil and Gas Power Division's meeting in Asbury Park will include six sessions with 12 technical papers on the subjects of Diesel-engine fuels, shaft couplings, marine Diesels, engine design, operation, and maintenance.

Noise and Corrosion Being Investigated

A COOPERATIVE research project at Rensselaer Polytechnic Institute, Troy, N. Y., to study sound control problems in air conditioning, will be sponsored by the American Society of Heating and Ventilating Engineers according to an announcement by A. E. Stacey, Jr., chairman of the Committee on Research. J. S. Parkinson, Manville, N. J., chairman of the Technical Advisory Committee on Sound Control, which has been responsible for outlining the research investigations, states that three factors of fundamental importance are essential in order to enable the engineer and contractor accurately to predict the noise levels in a conditioned space. First it is necessary to know the probable background noise levels which will be encountered in the conditioned spaces; second, it is necessary to know the amount of noise generated by the equipment and the air in the duct system; and, third, it is necessary to have a means of predicting sound attenuation through the duct system with and without the use of special sound absorbent materials.

The Rensselaer investigations are initially planned to develop a technique for measuring sound inside a duct and at the room outlet. Then the effect of duct size, thickness of metal, bends, elbows, turning vanes and splitters will be studied to determine the various attenuation losses which occur between the fan or conditioning apparatus and the room outlet.

Continued on Page 126

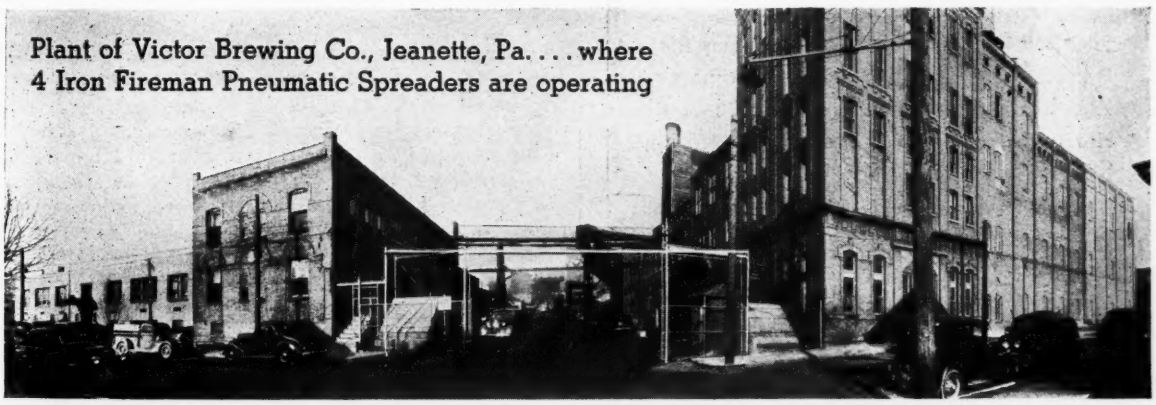
$1200 a month SAVED

. . . after IRON FIREMAN Replaced Other Stokers in Victor Brewery

When its boilers were fired by four stokers of another make, the Victor Brewery burned coal costing $3 a ton. During peak seasons, firemen were kept constantly on duty, poking the fires in order to enable three boilers to carry the load. Also, firemen had to watch for peak loads, and prepare fires 30 to 45 minutes in advance.

Now, with Iron Fireman Pneumatic Spreader stokers installed, the Victor Brewery burns coal costing only $2.36 a ton. Even during peak seasons, no more than two boilers are fired at any one time, and firemen are instructed to clean fires but once every eight hours. No preparation is needed for peak loads; the Iron Fireman stokers pick up the load as it comes on, without steam pressure dropping. Total fuel savings are $1200 to $1500 a month.

Four Iron Fireman Pneumatic Spreader stokers firing four 396 h.p. Erie City vertical water-tube boilers, in plant of Victor Brewing Company, Jeannette, Pennsylvania



Plant of Victor Brewing Co., Jeanette, Pa. . . . where 4 Iron Fireman Pneumatic Spreaders are operating

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There need be no guess-work about firing equipment purchases. An Iron Fireman Engineering Survey will determine accurately your possible savings and betterments. We will work with your own engineer, consulting engineer or fireman. Mail the coupon.

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☐ Send new catalog on Pneumatic Spreader.

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THESE new compact herringbone gear rotary pumps are built for small capacity and low pressure requirements.

- One stuffing box . . . minimum leakage
- Minimum floor space required
- Few parts . . . low maintenance
- Excellent suction lift qualities
- Four-bearing construction . . . long pump life
- Force-feed lubrication . . . no grease cups
- High pump efficiency . . . low power consumption
- Herringbone gears . . . more efficient and quieter than spur gears

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RPO-1A

Several short lengths of pipe made from different materials and arranged in series are being installed in a number of large New York office buildings for the purpose of studying corrosion problems, according to A. R. Mumford, chairman of the American Society of Heating and Ventilating Engineers' Research Committee on Corrosion.

Test specimens will be located in the returns of systems supplied with steam from a central district heating source and from individual boiler plants. Action of the return condensate from the heating system on the corrosion of the several pipe materials are to be observed over a long period and will be reported by the committee at various times.

New Uses of Nickel in Power Equipment

MORE power plants were erected in this last year than in any other of the past 8 yr. In these plants it is possible to obtain lower power costs because of recent advances in power plant design. Many industrial plants have added to their own power plants, operating at temperatures above 800 deg. F. and at pressures as high as 1350 lb.

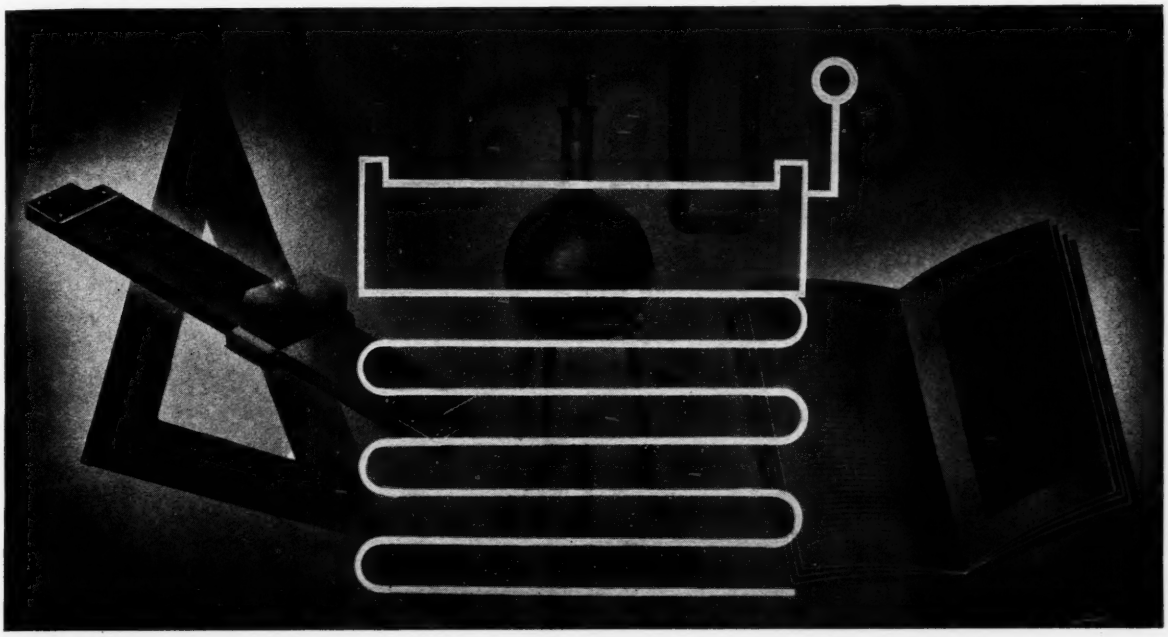
Combustion rate of coal has advanced greatly, which has necessitated increased use of soot blowing equipment and, with it, strong heat resistant alloys. Silicon hardened monel castings, inconel and rolled monel are all giving service in the high temperature parts as are 3½ per cent nickel steels in the operating worms. The use of "K" monel has increased for pump rods and the adoption of regular monel has extended to the handling of plain water because of the saving in packing costs. Likewise, monel and special copper-nickels are being found economical for the stems and seats of many brass valves handling water in the power plants.

Nickel-molybdenum steels for generator rotors have been adopted by a British manufacturer. High steam pressures and welded systems of piping have brought in the use of expansion joints and metal bellows made today in stainless steel, nickel and monel. It is standard British practice to use for the valve faces at high pressures and superheats castings of either silicon-monel or a bronze containing about 50 per cent nickel.

In Switzerland, an engineering firm has recently adopted a bronze containing approximately 2 per cent nickel for turbine runners because of its resistance to cavitation. Power plants are finding it economical to adopt the navy practice of refining their lubricating oils in high speed centrifuges, and monel high tensile forgings have become standard with some centrifuge manufacturers in Great Britain and the United States.

NEWSPAPERS and photographs can now be directly printed by radio. The method utilizes invisible ink, and heat from sparks controlled by electric impulses, so that no direct contact of stylus with paper is necessary. The "pyro" ink changes color when subjected to the heat of the spark, the type or picture being transmitted by points as in the usual scanning process of television.

CONDENSER TUBE SERVICE BY SCOVILL



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SERVICE IN METALS—Research in the Scovill laboratories is continually in process overcoming unusual conditions requiring more efficient condenser tube operation. For example, one of the latest results of Scovill research is Phosphorized Admiralty, developed for those installations where dezincification is pronounced. Scovill's condenser tube alloys are subjected to laboratory control from the time the alloys are cast until the tubes are finished ready for shipment.

SERVICE IN MEN—Scovill engineering representatives aid you in two ways. They first study your operating conditions and are then in a position to recommend the installation best suited to your needs. Secondly, they regularly go into the field to check on how tubes are performing in service, and to assist with your current problems.

SERVICE IN MANUALS—Scovill's many experiences in condenser and heat exchanger applications are the basis for the data contained in Scovill publications. A copy of the recently revised "Condenser Tubes" booklet is yours for the asking.

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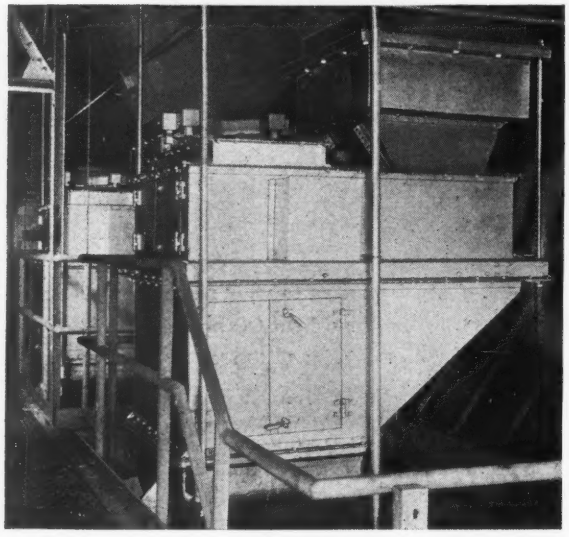

The sooner you install Richardson Scales in your boiler room the sooner will you be in a position to control operations and cut costs.

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To Guard Power Facilities

THROUGH the efforts of E. G. Moan, a power engineer associated with the District of Columbia Penal Institutions and a Special Deputy of the National Association of Power Engineers a plan has been submitted to and approved by President Roosevelt and other high officials of the national government for lending the assistance and support of power engineers to local, state and national governments in the operation and protection of the power generation and transmission facilities of the nation.

Numerous reports of subversive attempts to impair or destroy power facilities at different points justify the initiation of co-ordinated action to fulfill the purposes of the National Power Policy Committee. The plan of the national co-ordination idea invites the power and operating engineers of the nation to consider the importance their positions may bear to industry and national security established by their diligent and faithful discharge of duty.

Although this country has been enriched by the contribution of many nationalities, races, creeds, and colors, it is not without subversive agents, tendencies, and organizations. The patriotic engineer is anxious and determined to curb and eliminate these disrupting influences from the ranks of American engineers.

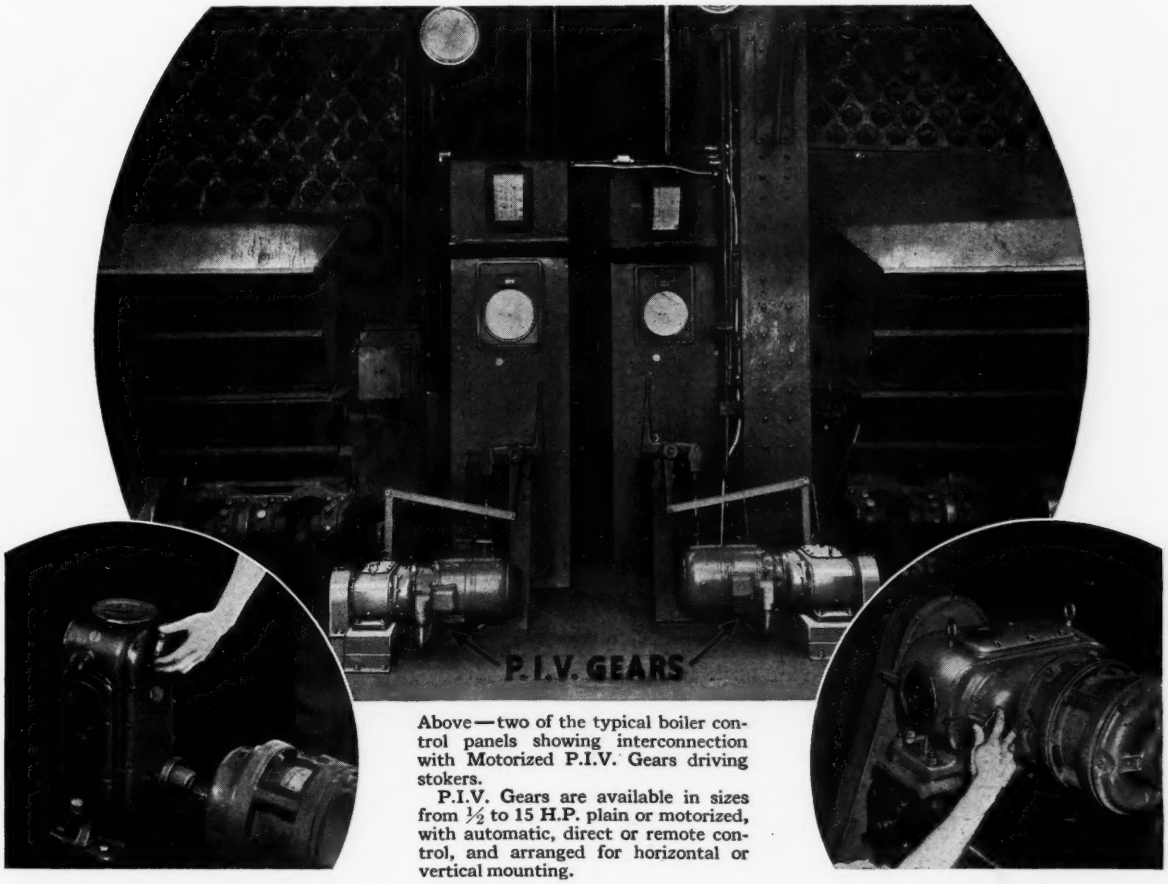
All interested engineering societies are requested to voluntarily assist in reporting to E. G. Moan, Box 25, Lorton, Virginia, any items of interest that may be in keeping with the purpose and intent of the National Power Policy Committee, and with the interest that the Federal Bureau of Investigation may have in the unhampered operation of all equipment under the supervision of power engineers.

LOTS OF MAGNESIUM is available in the earth's crust, but only since 1909 have its possibilities been utilized, the demand for lightness in World War aircraft giving impetus to use of this metal. Magnesium flares in fireworks are well known, also the use for alloying, especially with aluminum.

Now, extensive use is foreshadowed in a series of alloys known as Dowmetal, which contains 87 to 99 per cent magnesium, have specific gravity about 1.83, 1/3 lighter than aluminum and 1/4 the weight of iron or steel, yet having high toughness and tensile strength.

Widely used in aircraft, these alloys are now invading other industrial fields, one notable example being a pump casting which weighs nearly 2 tons less than would the same casting in iron. For portable tools such as motor-driven drills and hammers, spray guns and saws, the advantage is obvious. It is easily machined, readily cast in either sand molds or dies, can be welded by oxy-acetylene or electric process. Polished surfaces are subject to only a thin film of oxydation in unfavorable atmospheric conditions, but protective painting of surfaces is desirable where possible.

P.I.V. GEARS HELP BOOST BOILER EFFICIENCY IN COUNTRY'S LARGEST COTTON MILL



Above—two of the typical boiler control panels showing interconnection with Motorized P.I.V. Gears driving stokers.

P.I.V. Gears are available in sizes from ½ to 15 H.P. plain or motorized, with automatic, direct or remote control, and arranged for horizontal or vertical mounting.

To consume over 79,000 tons of coal with an increased efficiency of 8% indicates a substantial saving. This was accomplished at the Riverside and Dan River Cotton Mills, Danville, Va., after a trial installation proved that old boilers could be made more efficient through modern control. Six boilers ranging from 540 H.P. to 750 H.P. are now equipped with Bailey meter control systems which regulate fuel bed conditions through Link-Belt motorized P.I.V. Gears driving the stokers. The superintendent states that the fuel saved in one year will repay the cost of the complete installation many times.

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P.I.V.
GEAR
SPEED CONTROL

Many industries are finding the positive, infinitely variable speed control of the P.I.V. Gear an important factor in reducing waste, promoting uniformity and increasing saleable output. With this all-metal, compact unit, you can build into your machines, the versatility needed to meet today's varying production requirements. Book No. 1574 gives complete mechanical information and engineering data. Send for a copy, and for books on the other Link-Belt positive drives illustrated below.

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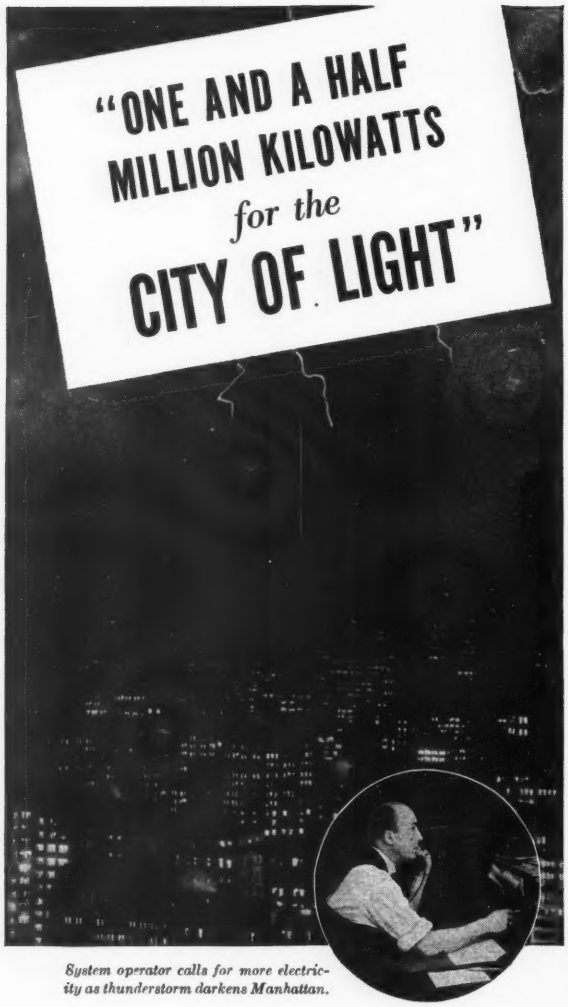

System operator calls for more electricity as thunderstorm darkens Manhattan.

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Members of the E. E. I. and their friends are cordially invited to visit New York on their way to or from the Convention. A hearty welcome, and some unforgettable moments, await you at the "City of Light"—a stone's throw from the Trylon and Perisphere.

OTHER POINTS OF INTEREST. *We also recommend a visit to the exhibits of the Gas Industries and of the Electric Utilities, as well as the individual displays in the Power Building.*

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FOR BUSINESS AND THE HOME

Conditioned Air Temperatures

NOON-DAY meals may account for that increased feeling of warmth and drowsiness which people experience during the afternoon, thus necessitating the maintenance of cooler conditions to satisfy comfort requirements in an air conditioned building. Tests conducted during 1938 involving the environment of 745 clerks in the home office building of the Metropolitan Life Insurance Co., New York City, indicate that the desired optimum indoor condition is about one degree lower in the afternoon than in the morning.

This investigation, together with others made in cooperation with the Committee on Research of the American Society of Heating and Ventilating Engineers in Minnesota, Texas, Washington, D. C., and Ontario, Canada, was planned to obtain conclusive information on the indoor requirements for different geographical regions of the country. Statistical findings of this study indicate that 70 deg. is the optimum effective temperature for office workers during the months of July, August and September. As effective temperature is a composite index of air movement, temperature, and relative humidity in the air, this 70 deg. optimum comfort may be interpreted to compare with a maintained condition of 74 deg. dry-bulb temperature and 60 per cent relative humidity in practically still air; this is also equivalent to 76 deg. dry-bulb temperature and 40 per cent relative humidity.

Optimum effective temperature for men was found to be 1.2 deg. lower than that for women, according to Dr. W. J. McConnell, director of the Industrial Health Bureau of the insurance company, who supervised the investigation. Men do not seem to be as susceptible as women to discomfort and this is especially true at the extremes of temperature recorded in this study. Another important observation indicates that the optimum effective temperature for the summer shows only slight variation from one month to another.

FOR OUTSTANDING WORK in production and utilization of calcium carbide and acetylene gas, Otto C. Voss, advisory superintendent of the tank and plate shop of Allis-Chalmers plant at West Allis, Wis., was awarded the James Turner Morehead Medal for 1939, at the meeting of International Acetylene Assn. in Milwaukee.

In his work in boiler construction, Mr. Voss acquired an interest in welding, and produced the first oxy-acetylene welded pressure vessels to pass code tests. Since 1905 he has been associated with Allis-Chalmers Mfg. Co., guiding manufacturing procedure, cutting and shaping of metals and formulating technique in the use of oxy-acetylene flame. At. 78 yr. he is still in active contact with metal fabrication, takes interest in athletic sports and energizes the bowling team with which he scatters the maple pins.

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Power Plant Construction News

Calif., Los Angeles—John Vander Giessen, 620 Bellflower Boulevard, has plans nearing completion for new one-story cold storage and refrigerating plant at 1327 East Artesia Avenue. Cost reported close to $25,000, with equipment. W. M. Bostock, 6221 Pacific Boulevard, Huntington Park, Calif., is consulting engineer.

Calif., Santa Barbara—City Council and Board of County Supervisors have plans under way for new permanent sand pumping plant in the yacht harbor, and will carry out project jointly. Fund of about $80,000 is available for plant.

Conn., Bridgeport—New England Ice Co., 224 Hallam Street, has plans for new one-story ice-manufacturing plant, 100 x 300 ft., on Knowlton Street, near Vernon Street, with second story extension, 40 x 50 ft., for office service. Cost estimated over $70,000, with equipment. Work will be placed under way soon. Keith S. Heine, 101 Mohawk Drive, Bridgeport, is architect.

Idaho, Pocahontas—Central Electric Federated Cooperative, Inc., Pocahontas, plans extensions and improvements in power plant, used for service for rural electric system, to include installation of Diesel engine-generating units and auxiliary equipment. Estimates of cost are being made. Financing will be arranged through Federal aid.

Ill., Woodstock—Water and Light Committee of City Council plans extensions and improvements in municipal power plant, including remodeling of boiler unit and installation of new stoker; new mechanical fans for water cooling tower, transformers and other equipment. Cost estimated about $33,000. P. E. Conway is chairman of committee.

Ind., Anderson—Guide Lamp Division, General Motors Corporation Twenty-sixth Street, Anderson, plans installation of electric power equipment in new one-story addition, 200 x 600 ft., to automobile lamp-manufacturing plant. Entire project will cost over $150,000. Proposed to carry out work during the summer.

Ind., Fort Wayne—International Harvester Co., 606 South Michigan Avenue, Chicago, Ill., plans installation of electric power equipment in new one-story addition, 145 x 685 ft., to branch plant at Fort Wayne. Proposed to begin work early in June. Entire project is reported to cost over $500,000. Company engineering department is in charge.

Ind, Kendallville—Board of Public Works, R. C. Moses, secretary, plans extensions and improvements in municipal power plant and waterworks station, with installation of new boiler units and other equipment. Cost estimated close to $75,000. It is proposed to engage an engineer soon to prepare plans.

Iowa, Brooklyn—City Council has plans under way for new municipal power plant. It is proposed to purchase local distribution system of Iowa Southern Utilities Co., and make extensions and improvements. Projects will be carried out soon. Cost estimated about $135,000. Stanley Engineering Co., Muscatine, Iowa, is consulting engineer.

Iowa, Cedar Rapids—Hubbard Ice & Fuel Co., 1124 First Street, N. W., plans new four-story and basement cold storage and refrigerating plant, about 60 x 150 ft. Cost estimated close to $90,000, with equipment.

Md., Hagerstown—City Council has plans under way for extensions and improvements in municipal power plant, with installation of additional equipment, including boilers and accessories. Bids are scheduled to be asked soon. Wood & Kirkpatrick, Stock Exchange Building, Philadelphia, Pa., are consulting engineers.

Mass., Somerset—Montaup Electric Co., Fall River, Mass., has engaged Stone & Webster Engineering Corporation, 49 Federal Street, Boston, Mass., consulting engineer, to design and supervise erection of new addition to steam-electric generating plant at Somerset. Installation will include turbine-generator units, high-pressure boilers and complete auxiliary equipment for large increased capacity. Cost reported close to $3,000,000.

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is an improved type of the straight tube level drum construction designed for a perfectly balanced circulation and a mechanical flexability that insures repeat orders for this type of boiler.

Built with one, two or three drums, depending on horsepower required.

MURRAY IRON WORKS COMPANY, BURLINGTON, IOWA

Mich., Comstock—Consumers Power Co., Jackson, Mich., has plans under way for new addition to Bryce Morrow steam-electric generating station at Comstock, with installation of equipment for increased capacity.

Minn., Minneapolis—Chicago, Milwaukee, St. Paul & Pacific Railroad Co., Third Avenue South and Washington Street, plans installation of electric power equipment in connection with extensions and improvements in locomotive shops at South Minneapolis. Entire project will cost close to $150,000. Work is scheduled to begin soon.

Mo., Lebanon—City Council has approved plans for extensions and improvements in municipal power plant, including installation of new 1500-kw. turbine generator unit, condenser and auxiliary equipment. Proposed to begin work soon.

Mo., St. Louis—A. Leschen & Sons Rope Co., 5909 Kenerly Avenue, plan installation of electric power equipment in new one-story addition, 35 x 150 ft., to wire rope-manufacturing plant. Entire project will cost over $50,000. Work will be placed under way soon.

Neb., Hastings—City Council has rejected bids recently received for 35,000-kw. steam turbine-generating unit, condenser and auxiliary equipment for installation in municipal power plant. Proposed to call for new bids soon. Plans have been approved for extensions and improvements in station, to cost about $280,000, with equipment. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

N. J., Clifton—Fritzsche Brothers, Inc., 76 Ninth Avenue, New York, N. Y., plans installation of electric power equipment in new two-story and basement addition to essential oil and chemical plant on Third Street, Clifton. Entire project reported to cost close to $175,000. Epple & Kahrs, 17 Washington Street, Newark, N. J., are architects.

N. Y., Schenectady—City Council plans new electric-operated pumping station for water system. Construction will be carried out in conjunction with waterworks expansion and improvements, entire project reported to cost in excess of $300,000. Malcom Pirnie, 25 West Forty-third Street, New York, N. Y., is consulting engineer.

N. C., Tuxedo—Green River Mills, Inc., plans installation of electric power equipment in new one-story addition, 100 x 135 ft., to yarn mill. An air-conditioning system, also, will be installed. Entire project will cost close to $65,000.

Ohio, Oberlin—Board of Trustees, Oberlin College, plans new power house for central-heating service at institution. Estimates of cost are being made. A fund of $1,000,000 is being arranged for this and other buildings at the college. Ernest H. Wilkins is president.

Ohio, Toledo—City Auto Stamping Co., Lint Avenue, plans installation of electric power equipment in new one-story addition to plant. Entire project will cost close to $400,000. Work will be carried out this summer. Albert Kahn, Inc., New Center Building, Detroit, Mich., is architect and engineer.

Ore., West Linn—Crown Willamette Paper Co. plans new overhead fuel conveyor at local newsprint mill, crossing Willamette River tailrace and operating between company sawmill and No. 2 grinder room. Structure will be supported by concrete and steel towers, and suspension cables, and will be built about 49 ft. above low water in river. Application has been made for permission. Company is an interest of Crown Zellerbach Corporation, 343 Sansome Street, San Francisco Calif.

Pa., Philadelphia—SKF Industries, Inc., Front Street and Erie Avenue, plans installation of electric power equipment in new one-story addition to ball and roller bearing-manufacturing plant. Entire project is reported to cost over $400,000. Work will be placed under way at once.

Pa., Pittsburgh—Duquesne Light Co., 435 Sixth Avenue, has plans under way for alterations and improvements in steam-electric generating station on Brunots Island, and will proceed with work soon. Cost reported over $100,000, including equipment.

Texas, Brownfield—City Council has plans maturing for extensions and improvements in municipal power plant, with installation of equipment for increased capacity. Bond issue of $90,000 has been authorized for project.

W. Va., Fairmont—Fairmont Coca-Cola Bottling Works, Inc., May Street and Morgantown Avenue, plans installation of electric power equipment, conveying and other mechanical-handling apparatus, in new two-story addition. Entire project will cost close to $100,000. Work is scheduled to begin at early date.

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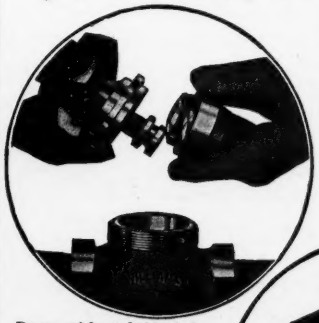

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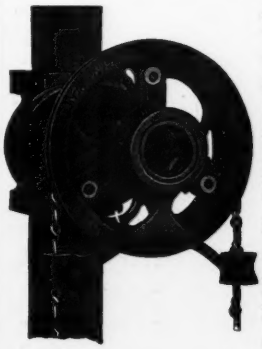

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